Detailed Project Report/Environmental Assessment

Point of Pines

Revere, Massachusetts

Coastal Flood Protection

October 1984

US Army Corps of Engineers

New England Division

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
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WALTHAM, MASSACHUSETTS 02254

REPLY TO
ATTENTION OF:

POINT OF PINES

REVERE, MASSACHUSETTS

COASTAL FLOOD PROTECTION STUDY

DETAILED PROJECT REPORT

POINT OF PINES
REVERE, MASSACHUSETTS
COASTAL FLOOD PROTECTION

MAIN REPORT

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SYLLABUS

Revere is a coastal community located immediately north of Boston and Winthrop in Massachusetts. Its shore area is divided into three separate zones: Roughans Point, Point of Pines, and Revere Beach. This report focusing on Point of Pines, prepared under authority contained in Section 205 of the 1948 Flood Control Act, is an interim response to the flood protection needs of Revere.

Flooding, due to storm tides and wave overtopping, is a constant concern. Average annual flood losses for Point of Pines are over $1.3 million. A recurrence of the "Blizzard of February 1978", the flood of record, would result in over $5.3 million in damages. Nearly 360 structures, almost all homes, would suffer flooding of an average of 4 to 6 feet in depth.

The Corps evaluated many alternative protective measures to reduce flood losses at Point of Pines. Input from a public involvement program, along with close coordination with the city of Revere, helped establish the necessary criteria leading to recommendation of a particular plan. Local residents desire a comprehensive solution offering a high degree of protection, while still preserving the qualities and values of the area's seashore location.

The recommended plan includes four different types of protection along the Point of Pines shore to minimize flooding from a recurring February 1978 storm - an event with about a 1 percent chance of occurrence in any given year. The proposed protection includes (1) 1,570 linear feet of stone revetment with beach sand replenishment, (2) 1,720 linear feet of sand dune replenishment and beachgrass planting, (3) 1,000 linear feet of concrete wall along the Saugus River entrance channel, and (4) 650 linear feet of concrete wall with stone slope protection at the west end of the project. It is estimated that this project would prevent 97 percent of the potential average annual damages at an estimated first cost of $4.4 million. This plan, with a benefit-to-cost ratio of 4.0 to 1, maximizes net economic benefits and causes no significant impacts on the environment. The plan is supported and sponsored by the city of Revere.

I. INTRODUCTION

In 1980 a reconnaissance scope study, performed under the special continuing authority of Section 205 of the 1948 Flood Control Act, as amended, determined the impact of the February 1978 flood of record on coastal areas of Revere, Massachusetts, and evaluated the extent of damages experienced. During that Section 205 investigation; the Revere area was separated into four separate zones: (1) Roughans Point, (2) Revere Beach, (3) Point of Pines, and (4) Oak Island and vicinity. That initial investigation determined that no flood control projects in the four zones of Revere could be recommended under the Section 205 authority, as all feasible alternatives had project first costs that exceeded the Federal cost limitation, at that time, of $3 million (declared disaster areas). Because of flooding hardships caused by northeast storms (particularly those of February 1978, February 1972 and December 1959) and initial findings that flood control improvements appeared to be economically justified, further study of the Revere coastal flooding area was initiated under the ongoing Southeastern New England (SENE) authorization.

During January 1982 legislation increased the Section 205 cost limitation to $4 million. Because the proposed plan of flood protection for Point of Pines had estimated costs of less than $4 million, local interests then requested that the remaining studies for the Point of Pines area be performed under the Section 205 authority.

A. STUDY AUTHORITY

By letter dated 1 June 1982 (see Section VIII) the Mayor of Revere requested that the Point of Pines study be conducted under the special continuing authority contained in Section 205 of the 1948 Flood Control Act, as amended. Specific authorization for the study was contained in OCE indorsement dated 16 July 1982, which provided initial funding for the Detailed Project Study (DPS). This Detailed Project Report (DPR) presents the findings of additional investigation for providing local flood protection in the Point of Pines section of Revere, Massachusetts.

The special continuing authority contained in Section 205 of the 1948 Flood Control Act, as amended, states:

> "The Secretary of the Army is authorized to allot from any appropriations heretofore or hereafter made for flood control, not to exceed $30,000,000 for any one fiscal year, for the construction of small projects of flood control and related purposes not specifically authorized by Congress, which come within the provisions of Section 1 of the Flood Control Act of June 22, 1936, when in the opinion of the Chief of Engineers such work is advisable. The amount allotted for a project shall be sufficient to complete Federal participation in the project. Not more than $4,000,000 shall be allotted under

this section for a project at any single locality. The provisions of local cooperation specified in Section 3 of the Flood Control Act of June 22, 1936, as amended, shall apply. The work shall be complete in itself and not commit the United States to any additional improvement to insure its successful operation, except as may result from the normal procedure applying to projects authorized after submissions of preliminary examination and survey reports."

B. SCOPE OF STUDY

Detailed investigations have been made to determine the extent of problems and opportunities related to coastal flooding in the Point of Pines section of Revere. This predominantly residential sub-division has periodically been subjected to tidal flooding from severe northeast storms and less frequently from storms of hurricane intensity.

This DPR documents the various stages of the planning process, from formulation and screening of alternative plans to the selection of the plan that best addresses the problems and opportunities (outlined below), maximizes net economic benefits and is acceptable to local interests.

(1) Problem and Opportunity Statements Within the Point of Pines study area, for the planning period of 1985 to 2085:

. Reduce damages caused by coastal flooding
. Protect and enhance the values and qualities of the shorefront environment

Coastal flooding is a complex problem that requires an interface of various engineering disciplines to determine the proper solution. Storm tide elevations and runup analyses for breaking and non-breaking waves were determined for the existing conditions and the various alternative protective measures investigated. From these studies, cost estimates were prepared and residual damages calculated for the various alternatives. Detailed economic investigations have also been performed to derive the benefits from each alternative plan.

A complete assessment of the potential environmental impacts of the alternative flood protection measures has been accomplished. Also, an evaluation of most probable future conditions at Point of Pines is included to enable the reader to make a complete comparison of alternative plans.

C. STUDY PARTICIPANTS AND COORDINATION

Throughout the planning process coordination of the study was maintained with Federal, State and local officials as well as members of the Point of Pines Beach Associaton and other residents of the study area. Meetings have been held to exchange information concerning past floods at Point of Pines and possible remedial action to prevent future flood losses in this shorefront residential community.

Two of the earlier workshop type meetings occurred during March 1982 and November 1982. At these meetings residents of Point of Pines and the Point of Pines Beach Association stated that they were in favor of flood control measures for their area, especially in light of the extensive damages suffered during the February 1978 storm, but would prefer to have the top of protection elevation set so that their view of the beachfront would not be obscured significantly. Also, they did not want a high level protection if it resulted in reducing their usable sand beach.

After much coordination, planning and engineering, the findings were presented to local officials and citizens and members of the Beach Association during June 1984. At this time, the alternative selected for recommendation (Plan E) was discussed. Those present endorsed the selection and were very supportive of its prospective implementation. The draft Detailed Project Report and Environmental Assessment were distributed to Federal, State and local agencies for their comment during October 1984. A letter of intent from the local sponsor(s) is included in Section VIII-Correspondence. Coordination with U.S. Fish and Wildlife Service has resulted in planning aid letters also exhibited in Section VIII.

D. STUDY OBJECTIVES AND CONSTRAINTS

The study conducted under SENE authority determined that justification exists for Federal participation in the implementation of flood control improvements at Point of Pines. The primary objective of this investigation is to expand and refine the earlier findings and develop a viable plan of flood control that satisfies the problems and opportunities.

The Corps of Engineers seeks plans that provide solutions for water resource problems, especially to reduce future flood damage within the study area. Wherever possible, these plans will incorporate features that protect or enhance the area's environmental quality. Based upon a preliminary assessment of the flood problems, needs and opportunities in the study area, the following study objectives have been developed.

- Recommend the plan that reasonably maximizes net economic development (NED) benefits, consistent with protection of the environment, unless there are believed to be overriding reasons favoring the selection of another alternative.

- Reduce the coastal flood threat at Point of Pines to life, property and quality of life.

- Develop a flood damage reduction program which contributes to the environmental quality of Point of Pines and preserves its inherent values.

In addition, planning efforts should not render ineffective the objectives of other agencies. Any plan should complement regional long range management plans. Formulation of a plan, for example, must be in agreement with the Coastal Zone Management Act of 1972 and the environmental provisions of Section 404 of the Federal Water Pollution Control Act, as amended by the Clean Water Act of 1977.

The Coastal Zone Management Program provides that:

> "Each Federal agency conducting or supporting activities directly affecting the coastal zone shall conduct or support those activities in a manner which is, to the maximum extent practicable, consistent with approved state management programs."

The Statewide Comprehensive Outdoor Recreation Plan (SCORP) prepared by the Department of Environmental Management (DEM), recommends: "that recreational needs be met... and that priority be placed on satisfying the needs for the most widely demanded recreational activity." The plan identifies swimming as the most popular recreational activity and finds that urban areas, particularly the greater Boston area, have the highest need for new recreational facilities.

The State Growth Policy Plan, prepared by the Office of State Planning (OSP), recommends that new growth and development be channeled to existing urban centers or to regional development centers, and that State programs of public investments adhere to the policy and support urban development.

Plans have been prepared by the city of Revere, the MDC, and private concerns for redevelopment of the beach area to the south of Point of Pines. These include the construction of two residential complexes, one to be luxury apartments and an elderly housing project, and the other to be condominiums. The MDC is building a park on its Revere Beach Restoration and the MBTA is planning to extend its Blue Line public transportation system, rebuild the Wonderland Station, and construct a parking garage. A shopping/office mall is also planned.

A survey of Point of Pines residents conducted last year and meetings with local interests throughout the study have identified a desire for a high degree of protection, while still preserving the qualities and values of the area's seashore location.

Planning was conducted in accordance with Principles and Guidelines issued May 1983. Plans were formulated with regard to the goal of national economic development consistent with protection of the environment. Economic development is enhanced by increasing the value of the Nation's output of goods and services and by improving national economic efficiency. The quality of the environment is enhanced by protection from degradation, conservation, preservation, and restoration of natural and cultural resources.

In addition, Section 73 of the Water Resources Development Act of 1974 mandates:

> "(a) In the survey, planning or design by any Federal Agency of any project involving flood protection, consideration shall be given to nonstructural alternatives to prevent or reduce flood damages, including, but not limited to, floodproofing of structures; flood

plain regulation; acquisition of flood plain lands for recreation, fish and wildlife, and other public purposes; and relocation with a view toward formulating the most economically, socially and environmentally acceptable means of reducing or preventing flood damages."

Water resources planning conducted by the Corps must develop, through public involvement, plans solving flood problems in conjunction with other urban planning programs. This interactive planning process involved:

. Addressing specific flood problems, issues and concerns identified by the public;

. Being flexible in accommodating changing economic, social, and environmental patterns and technologies;

. Integrating and complementing other urban development and management programs;

. Coordinating with affected public agencies, interest groups and individuals;

. Developing plans through an orderly, structured and open planning process; . Ensuring plan implementation, with respect to financial and institutional capabilities and public consensus;

. Adhering to Corps of Engineers policies and regulations and other Federal laws; and

. Where applicable, receiving approval by appropriate State and Federal agencies.

E. <u>OTHER STUDIES</u>

(1) <u>Section 205 Reconnaissance Study</u>

A reconnaissance scope study of coastal flood protection problems and needs of Revere, Massachusetts, performed under Section 205 of the 1948 Flood Control Act, as amended, was submitted by the Division Engineer to the Chief of Engineers in February 1980. This preliminary study, as noted earlier, focused on all coastal flood prone areas of Revere. Detailed studies of the Point of Pines area were subsequently made under Section 205 authority. Detailed studies for the other areas were pursued under the Southeastern New England authority.

(2) <u>Section 107 Detailed Project Report</u>

A preliminary study of recreational navigation needs in the Pines River area, by the New England Division under Section 107 of the 1960 River and Harbor Act, as amended, resulted in approval of a reconnaissance report by the Chief of Engineers in September 1979. Preparation of a Detailed Project Report is currently underway.

(3) SENE (Southeastern New England) Study

The SENE study was authorized by a resolution adopted 12 September 1969 by the Senate Committee on Public Works. The resolution provided for a study to determine "...the feasibility of providing water resource improvements for flood control, navigation and related purposes in Southeastern New England...with due consideration for enhancing the economic growth and quality of the environment."

The resultant study, which was completed in 1975 identified the critical problems of tidal flooding prior to the disasterous blizzard of February 1978, which caused severe destruction along the Massachusetts coast. The study of flood conditions in Revere was initiated under this resolution during fiscal year 1980.

Flood protection and other related needs for Revere Beach itself and the backshore area of Revere Beach, which includes the Oak Island area, are currently under investigation. Alternatives being considered include a variety of beach restoration options, park flood control embankments, rock revetments and concrete walls along Revere Beach and dikes, walls and road raising along the Pines River. Preliminary indications are positive toward a recommendation.

A final report on Roughans Point, just south of Revere Beach, was approved by the Board of Engineers for Rivers and Harbors (BERH) during January 1984. The recommendation proposes a rock revetment along the shore to dissipate wave energy and reduce coastal flood damage. The current estimated project first cost is $8.2 million. The report is presently being reviewed by the Chief of Engineers prior to consideration by the Assistant Secretary of the Army for Civil Works for submittal to Congress. The New England Division is currently conducting detailed studies to continue planning and engineering prior to project construction.

II. PROBLEM IDENTIFICATION

This section identifies the without project condition associated with coastal flooding at Point of Pines. It describes the most probable future conditions for related water resource problems in the study area assuming no Federal participation in flood protection. Alternative flood protection plans are assessed and evaluated by comparison to this "without project" condition.

A. EXISTING CONDITIONS

The city of Revere is located in Suffolk County on the Massachusetts coast, about 2 miles northeast of the East Boston section of the city of Boston. About one-fifth of its area is a salt marsh adjacent to the Pines River estuary, and about one-third of the city, including the marsh area, is below elevation 10 feet, National Geodetic Vertical Datum (NGVD - formally mean sea level datum of 1929). The study area addressed by this report is the northern most coastal region of Revere - Point of Pines. This residentail neighborhood suffers flooding on a periodic basis. This report focuses on the problems, needs and opportunities related to coastal flooding at Point of Pines.

The remainder of the city is gently rolling with a few steep hills, the highest elevation being at the reservoir on Fennos Hill at about 192 feet NGVD. Most of the land above 10 feet NGVD is fully developed and, for all practical purposes, any new development could be expected only at the expense of existing uses. The population of the city is about 42,000. In addition, beach studies conducted by the Corps last year found that on peak summer days more than 16,000 people visit the 3.5-mile long Revere Beach area for recreation. This beach is located immediately to the south of the Point of Pines peninsula.

(1) Study Area

The Point of Pines section of Revere is a roughly triangular shoreline peninsula located at the northerly end of Revere Beach between Carey Circle and the mouth of the Saugus River. About 360 residences, a school, yacht club, fire station, and two churches are located in this area which features about 3,000 feet of shorefront. The maximum width of the peninsula between the ocean and the Lynnway (the main north-south roadway) is about 1,200 feet. The 60 acre peninsula includes 13 roadways which connect the Lynnway with Rice Avenue which extends along the shorefront. The following map (Plate 1) shows the general configuration of the Point of Pines peninsula and surrounding areas.

The geography of Point of Pines is such that the widest beach is located at its northerly end, near the mouth of the Saugus River. This has accreted over the years without significant impact to the Saugus River channel. The area near Carey Circle at the southern end of Point of Pines

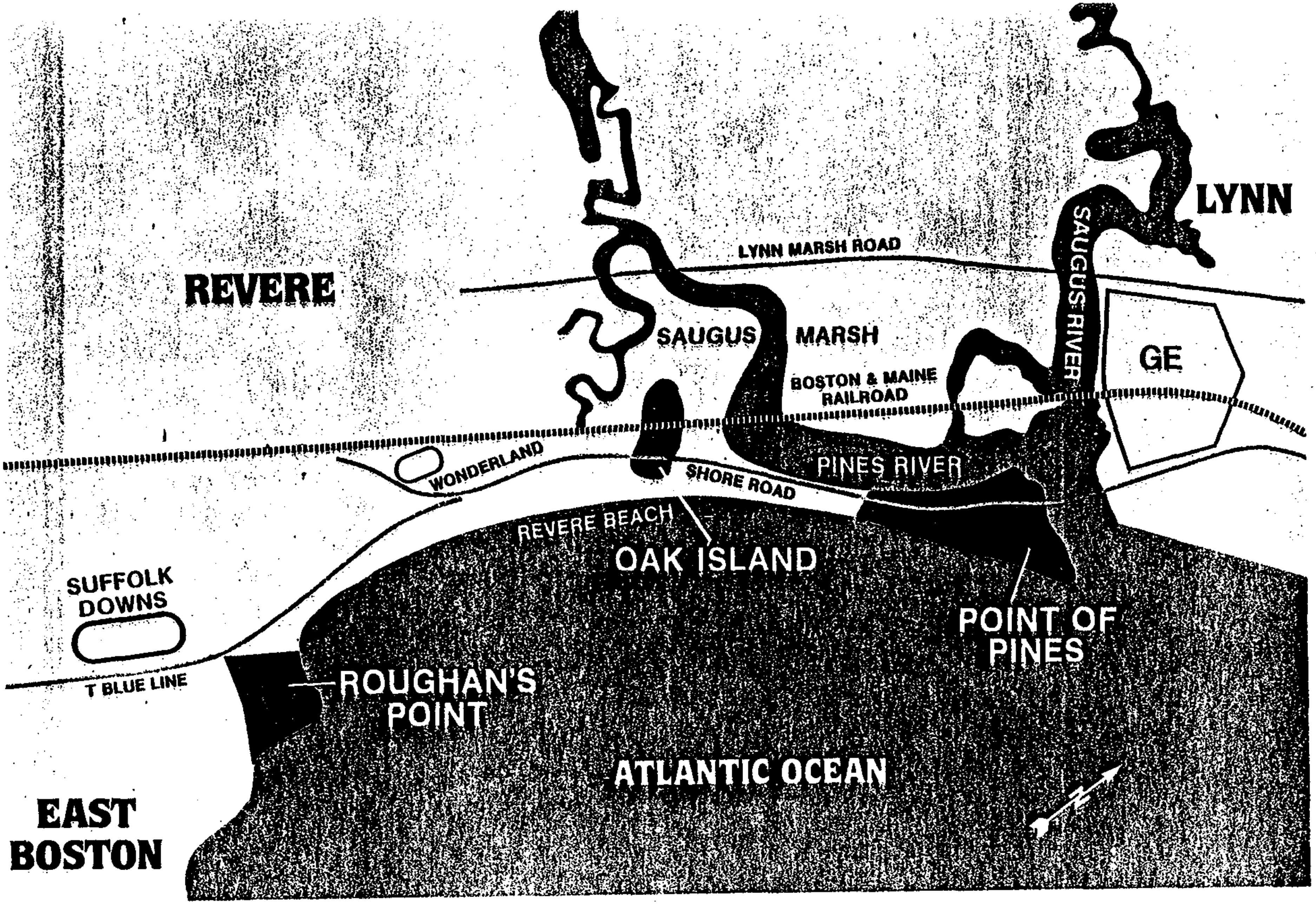

LYNN
LYNN MARSH ROAD
SAUGUS RIVER
REVERE
SAUGUS
MARSH
GE
BOSTON & MAINE
RAILROAD
WONDERLAND
SHORE ROAD
PINES RIVER
REVERE BEACH
OAK ISLAND
SUFFOLK
DOWNS
POINT OF
PINES
T BLUE LINE
ROUGHAN'S
POINT
ATLANTIC OCEAN
N
EAST
BOSTON

PLATE 1

has no remaining beachfront at high tide because of the prevailing littoral drift of sand. This area is provided some shelter from storms with northeasterly winds by the Lynn-Nahant causeway, located just over one mile to the east.

Initially the study area was divided into 7 reaches based on existing features of the shorefront noted below:

REACH	LENGTH	SHOREFRONT FEATURE
A	230'	Carey Circle
B	440'	Revetment
C	430'	Precast Concrete Wall & Revetment
D	430'	Poured Concrete Wall
E	1720'	Sand Dune
F	970'	Precast Wall (Riverfront)
G	730'	Beach & Yacht Club

The location of these reaches is shown on Plate 2. A description of the existing features in each of the seven reaches follows:

REACH A: This 230-foot long section, located immediately adjacent to the north end of Revere Beach consists of a 12-foot high vertical concrete wall that extends in a semi-circle around Carey Circle. The top of the wall is at elevation 15 feet above NGVD and is 2.5 feet wide. The top two vertical feet of wall form a parapet, 3.5 feet above a bituminous concrete sidewalk on the landside of the wall.

The oceanside face of the concrete wall shows its age with the "scars" of past storms. There are several areas where the surface concrete has been displaced or spalled. This deterioration however has not impaired the wall's structural integrity yet. High tide abutts the wall, partially inundating large stones placed at its base on the beachside. Without attention, it is only a matter of time before the wall's stability will be threatened.

In fact, the beach at low tide is only 200 feet wide. In the Blizzard of '78, waves hitting the wall deflected 20 feet into the air and overtopped the wall spilling volumes of water in all directions away from Carey Circle. Water flowed down the Lynnway, contributing to flooding of homes to the east and west of the Lynnway.

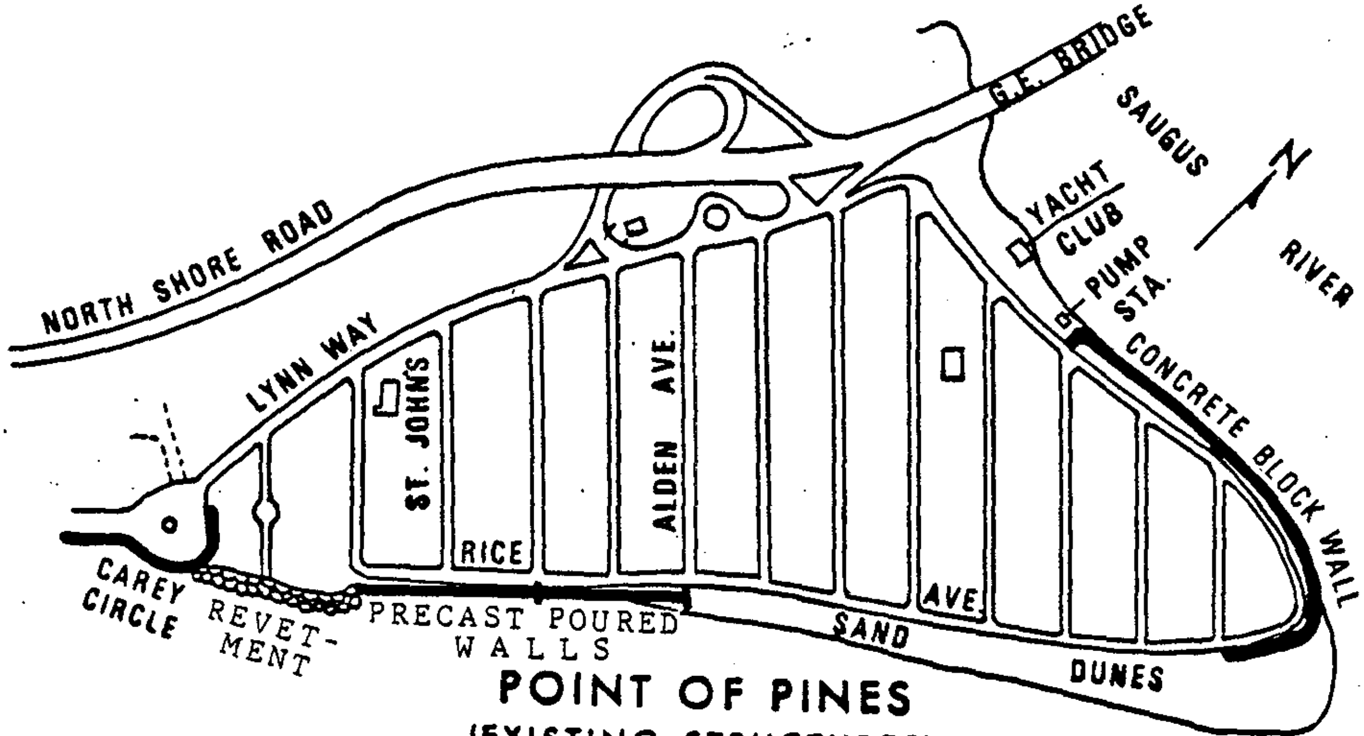
REACH B: This 440-foot long section extends in a generally northeasterly direction from Carey Circle in front of a few residential properties. The shorefront is protected by a rock revetment with an average top elevation of 15± feet NGVD. The revetment is about 12 feet high constructed with the large stones placed on a slope of about a 1 vertical to 1 horizontal. The average weight of these cover stone is 2 to 4 tons. During several floods, the rock has been displaced and patios torn out by overtopping waves. At high tide there is no exposed beach. The water extends about 2 feet up the rock surface. Concrete and bituminous concrete patios on the landside of the revetment are at elevation 14± feet NGVD.

REACH C: This 430-foot long section is a continuation of the shore protection (revetment) of Reach B. However, this was separated out because there is a 5-foot high precast concrete wall (Jersey Barrier type) at the top of the revetment. There are 61 of these barrier wall sections, 6.9 feet long each. The top elevation of the wall is 15+ feet NGVD. Also, the landside of the wall is different from Reach B in that a 17-foot wide, asphalt covered, apron slopes from the base of the wall to the edge of Rice Avenue (see photo). Rice Avenue is a 20-foot wide, bituminous paved roadway extending northeasterly around Point of Pines. A high tide in this reach, the existing sand beach is nonexistent at its southerly end and 50 feet wide at its northerly end. In the Blizzard of 78, water overtopped here undermined the asphalt apron and moved much of the revetment stone seaward.

REACH D: This 430-foot long section is differentiated from Reach C by a poured concrete wall that forms another type of shoreline protection. This concrete wall has 7.7 feet exposed at its south end and 3 feet at its north end. It has a top width of 2.4 feet at elevation 14± feet NGVD. The landside configuration is the same as in Reach C. Details of the wall footing are unknown but is thought to extend about 6 to 10 feet below the present sand beach surface. There is no exposed rock at the base of the wall. The beach width at high tide varies from 50 feet at the southerly end of the reach to 100 feet at the northerly end. As in the previous reaches, wave overtopping occurs here during severe storm events.

REACH E: This is the longest continuous section of beachfront extending for about 1,720 feet to the mouth of the Saugus River. It is characterized by a wide beach, sand dunes, and sparse vegetation. The top elevation of the dunes varies between elevations 12.1 and 16.6 ft NGVD, with the lower areas primarily being where pedestrian traffic to the beach has worn down the dunes. These low areas do not support any vegetation at all. At the curve in Rice Avenue to the north there is a low concrete wall adjacent to the street pavement. It has a top elevation of 12.6 ft NGVD and a length of about 250 feet. At the height of the '78 storm, waves overtopped the dunes especially through the low areas.

REACH F: This 970-foot long section extends westerly along the Saugus River and is roughly perpendicular to those reaches previously described. A precast concrete seawall (6.9 feet long each, Jersey Barrier type, 137 sections), with a top elevation of about 12.0 ft NGVD is located adjacent to Rice Avenue. The sand beach in front of the wall varies between 20 and 100 feet in width at high tide. In 1978, water came over the protection and flowed through the cracks between wall sections. However, Reach F and Reach G below are not subjected to direct wave action.



POINT OF PINES
(EXISTING STRUCTURES)

BROAD SOUND

STUDY AREA

PLATE 2

REACH G: This final section extends 730 feet from Reach F to the embankment of North Shore Road at the General Edwards Bridge. An existing pumping station is located at the east end of this reach. Also, the Point of Pines Yacht Club and its pier is situated about mid-way along this stretch. The beachfront width between the river and Rice Avenue varies from 100 feet near Reach F to 60 feet near the North Shore Road embankment. High ground along most of this reach is between 8.0 and 9.0 ft. NGVD. Rice Avenue is flooded almost annually, with depths of 3 to 5 feet experienced during the '78 event.

(2) Geotechnical Conditions

• Topography. The Point of Pines area is located within the seaboard lowland section of the New England physiographic province. The area is characterized by a relatively flat, seaward-sloping region, predominantly under 100 feet NGVD. Glacial features, such as drumlins, usually provide higher relief in the area.

• Geology. In the regions of higher elevation, the overburden consists primarily of glacially derived material. Till, an unsorted mixture of clay, sand, gravel, and boulders is common and generally overlies bedrock. Glacially derived, stratified sand and gravel deposits are occasionally found overlying the till. A relatively recent sequence of lagoonal silts and clays, peat and organic silt, and beach deposits of sand and gravel overlies the glacial deposits.

The principal bedrock type in this area is the Cambridge slate, also known as the Cambridge Argillite. It is a thinly-bedded to massive, sedimentary rock composed of clay-sized particles. Intrusive and extrusive igneous rocks are also found in this region. The available subsurface information indicates that bedrock along the existing shore protection is found to be deeper than 30 to 40 feet below ground surface.

• Seismicity. The Point of Pines area is located within Zone 3 of the seismic zone map of the United States. This is a modification of the seismic risk map developed by the Environmental Science Administration and the U.S. Coastal and Geodetic Survey and is contained in Engineering Regulation 1110-2-1806, dated May 1983. In accordance with this directive, a coefficient of 0.15g is recommended for use in any evaluation of seismic stability of concrete structures in final design.

• Foundation Investigations. In conjunction with the preparation of this report, eight 30-foot deep foundation drive-sample borings were completed in 1982. Additional subsurface exploration data, including foundation boring records provided by the Massachusetts Department of Public Works, was also utilized in assessing the foundation conditions at Point of Pines. No explorations were made for rock or soil borrow because soil and rock construction materials are planned to be obtained from commercial sources. The completed subsurface exploration program is considered adequate for design purposes and construction control.

Classification and description of soils found in foundation explorations completed specifically for this project in 1982 are shown on The Geologic Log Profile Plate included and discussed in Appendix B.

•Groundwater Conditions. Groundwater levels in the study area are controlled by tidal action. The normal tide range at Point of Pines is from elevation -4.6 and +4.9 feet NGVD.

•Design Considerations. In view of the lack of detailed design plans for the existing facilities, visual observation of the site, inability of the existing protection system to meet current Corps of Engineers design criteria, and the foundation conditions, the existing flood protection measures are considered unstable for design stillwater elevations and wave heights being considered in this study.

•Construction Materials. Anticipated construction materials will be sands and gravel for fill materials, concrete aggregate, and rock for the stone berms. All of these materials are available from commercial suppliers within a 40-mile radius of the project area.

(3) Climatology

The climate of Revere is typical of lower coastal New England--cool, semi-humid, and most variable. Eastern Massachusetts is located within the North Temperate Zone, whose climatology is typical of its latitude and location on the easterly side of a large continent.

Two distinct types of storms, distinguished primarily by their place of origin as being extratropical and tropical cyclones, influence coastal processes in New England. These storms can produce above normal tide levels and must be recognized in studying New England coastal problems.

a. Extratropical Cyclones. These are the most frequently occurring variety of cyclones in New England. Low pressure centers frequently form or intensify along the boundary between a cold dry continental air mass and a warm moist marine air mass just off the coast of Georgia or the Carolinas and move northeastward more or less parallel to the coast. These storms derive their energy from the temperature contrast between cold and warm air masses. The organized circulation pattern associated with this type of storm may extend for 1,000 to 1,500 miles from storm center. The wind field in an extratropical cyclone is generally asymmetric with the highest winds in the northeastern quadrant. Since the storm center generally passes parallel and to the southeast of the New England coastline, highest onshore wind speeds are generally from the northeast. For this reason these storms are called northeasters or "nor'easters" by New Englanders. As the storm passes, local wind directions may vary from southeast to slightly west of north. Coastlines exposed to these winds can experience high waves and extreme storm surge. Such storms are the principal tidal flood producing events at Revere. The prime season for northeasters in New England is November through April.

b. Tropical Cyclones. These storms form in a warm moist air mass over the Caribbean and the waters adjacent to the West Coast of Africa. The air mass is nearly uniform in all directions from the storm center. The energy for the storm is provided by the latent heat of condensation. When the maximum wind speed in a tropical cyclone exceeds 75 mph, it is labeled a hurricane. Wind velocity at any position can be estimated based upon the distance from the storm center and the forward speed of the storm. The organized wind field may not extend more than 300 to 500 miles from the storm center. Recent hurricanes affecting New England generally have crossed Long Island Sound and proceeded landward in a generally northerly direction. However, hurricanes tracks can be erratic. The storms lose much of their strength after landfall. For this reason the southern coast of New England experienced the greatest surge and wave action from the strong southerly to easterly flowing hurricane winds. However, on very rare occasions, reaches of coastline in northern New England may experience some storm surge and wave action from the weakened storm. Hurricanes are not a principle cause of tidal flooding at Revere. The hurricane season in New England generally extends from August through October.

Coastal areas such as Revere are subjected to considerable maritime influence because of their proximity to the Atlantic Ocean. Winters are warmer and summers pleasantly cooler than locations slightly inland of the ocean's tempering effects. Winter coastal storms often bring rainfall to Revere, in contrast to snow in interior portions of the State. Influences due to topography on the climate are minor because of the relatively small extremes of elevation within the area.

The highest temperatures of the year are usually 90 to 95 degrees Fahrenheit (F). During the summer, nights are usually cool with readings in the 50's and 60's. The average temperature in the summer (June - August) is 71°F and varies little from year to year. The average winter (December - February) temperature is about 30°F. During some winters, the temperature may never fall below zero, and yet during others, as many as 20 days with subzero temperatures may occur.

Although the month-to-month average precipitation is fairly constant, and no "wet" and "dry" seasons exist as such, there is a notable decrease in precipitation during the summer. The May through August period averages about 3.0 to 3.5 inches per month, whereas the winter and spring months receive about 3.5 to 4 inches each. Rarely does any month experience more than 10 inches of precipitation or less than 1 inch. Short periods of drought may occur in any season. The annual precipitation, averaging about 42 inches, is fairly constant from year to year and usually provides enough water to combat drought.

The bulk of snowfall occurs from December through March, although measurable amounts fall in April and November. The amount of annual snowfall is subject to wide variation from year to year and from location to location in the Boston metropolitan area.

(4) Significant Storms

Flooding in Revere is not a new problem. It has been experienced since the area was first settled over 200 years ago. Damages occur on an annual basis, with severe flooding on an average of every 8 years. Because of the physical character of Point of Pines, flood elevations in portions of the interior are usually higher than the event's associated stillwater tide level. The more notable storms with record tides, resulting in significant flooding, are described below. Actual recorded damages are sketchy at best. Losses due to the more recent events are documented wherever possible.

26 December 1909 The "Christmas Gale" produced an observed tide of 9.9 feet NGVD at Boston. Historical records indicate that a wind velocity of about 85 miles per hour was experienced.

4 March 1931. This "northeaster" brought severe winds and high seas. A maximum tide of 8.8 feet NGVD was observed in Boston during this storm.

21 April 1940. The storm of 1940 brought high tides and strong winds. Boston Harbor recorded maximum stillwater tide heights observed of 8.9 feet NGVD.

30 November 1944. The tide elevation observed in Boston was 8.8 feet NGVD. This storm was classified as a "northeaster" with strong winds prevailing from the north and northeast.

29 December 1959. During this northeaster, observed tides rose to 9.3 feet NGVD, causing extensive damage at Revere Beach with considerable loss of sand and undermining along the seawall due to heavy wave action. Major damage occurred at Roughans Point (45 homes), Point of Pines (120 homes), and the Riverside area (30 homes). Also, many commercial establishments were affected due to overtopping of beaches and walls causing flooding in low areas. Revere, as a whole, suffered about $1 million in damages at 1959 price levels. This would be over $4 million in today's dollars.

26 May 1967. This storm came especially late in the season. The northeaster's movement was slow due to a blocking high pressure ridge, and coincident spring tides combined with gale force winds causing extensive beach erosion. In Boston, maximum tide heights reached 8.9 feet NGVD observed.

19 February 1972. A deep low-pressure area moving at about 25 miles per hour over outer Cape Cod produced storm surges of 4.0 feet at Boston,

superimposed on the coincident spring tides. Observed maximum tidal elevations in Boston reached 9.1 feet NGVD. Revere suffered almost $1.1 million in damages to public facilities alone. This would be over $2 million at today's price levels.

7 February 1978. While areas were still in the process of recovering from the effects of a 20 January 1978 blizzard, New England was struck by one of the most intense, persistent, severe winter storms of record. The storm moved slowly eastward just south of New England, as a circular upper atmospheric low moved over the surface circulation. It produced intensely strong winds, including recorded gusts of 79 mph and great amounts of snow over most of southern New England. Tidal elevations in Boston Harbor reached the highest recorded at 10.3 feet NGVD. It is estimated that this storm produced a stillwater tide level at Revere having an approximate frequency of occurrence of once in 100 years. At Point of Pines, interior flood elevations reached a maximum of 13.0 feet NGVD, due principally to water from wave overtopping the existing flood protection measures. Damages caused by this "Great Blizzard" are discussed later.

25 January 1979. Heavy rains and strong onshore winds from the northeast created high tides and flood conditions in Revere. However, just before the high tide, winds unexpectedly shifted and flood losses were thereby reduced.

Because overtopping occurs at different locations and there is a flood level gradient from south to north, Point of Pines was divided into four different zones for use in flood damage surveys. The four zones were delineated as flood level isograms based on studies of the topography and reported historic flood levels. The four zones are depicted on Plate 3. Climatology and tidal hydrology are further discussed in Appendix A. There, the methodology used to develop the stillwater tide level and flood elevation frequency relationship for Point of Pines, shown on Plate 4, is explained. Tide levels reported for Boston Harbor are, for all practical purposes, the same for the Revere area.

(5) Environment

As described earlier, Point of Pines is a low-lying point of land at the north end of Revere Beach. The area is comprised of approximately 360 residential structures bounded by Carey Circle, Rice Avenue (along the shorefront), the Lynnway and the Saugus River. Over half of the Point's area is subjected to flooding on almost a yearly basis. Coastal storm protection is currently provided by a stone revetment, concrete seawalls and sand dunes along the easterly shore as outlined previously.

The Revere Beach area, from Roughans Point to Lynn, and the Saugus and Pines Rivers have historically been popular fishing areas. Indians once fished here for abundant salmon, trout, alewives and bass. Early colonists established commercial fishing for bass, herring, and cod. By the nineteenth century, commercial fishing in the area expanded to include haddock, mackerel, cunner, and eels. The area still supports popular sport fishing activities. There are 31 species of finfish in the area. No endangered species have been identified. Planning aid letters from the Fish and Wildlife Service are included in Section VIII.

(6) Recreation

The adjacent Revere Beach, stretching nearly three miles to the south from Point of Pines is the primary recreation resource to the region. Recent construction of a new waterfront park at the site of the former amusement center along Revere Beach is part of a comprehensive program to revitalize and increase both the region's recreational resource value and economy.

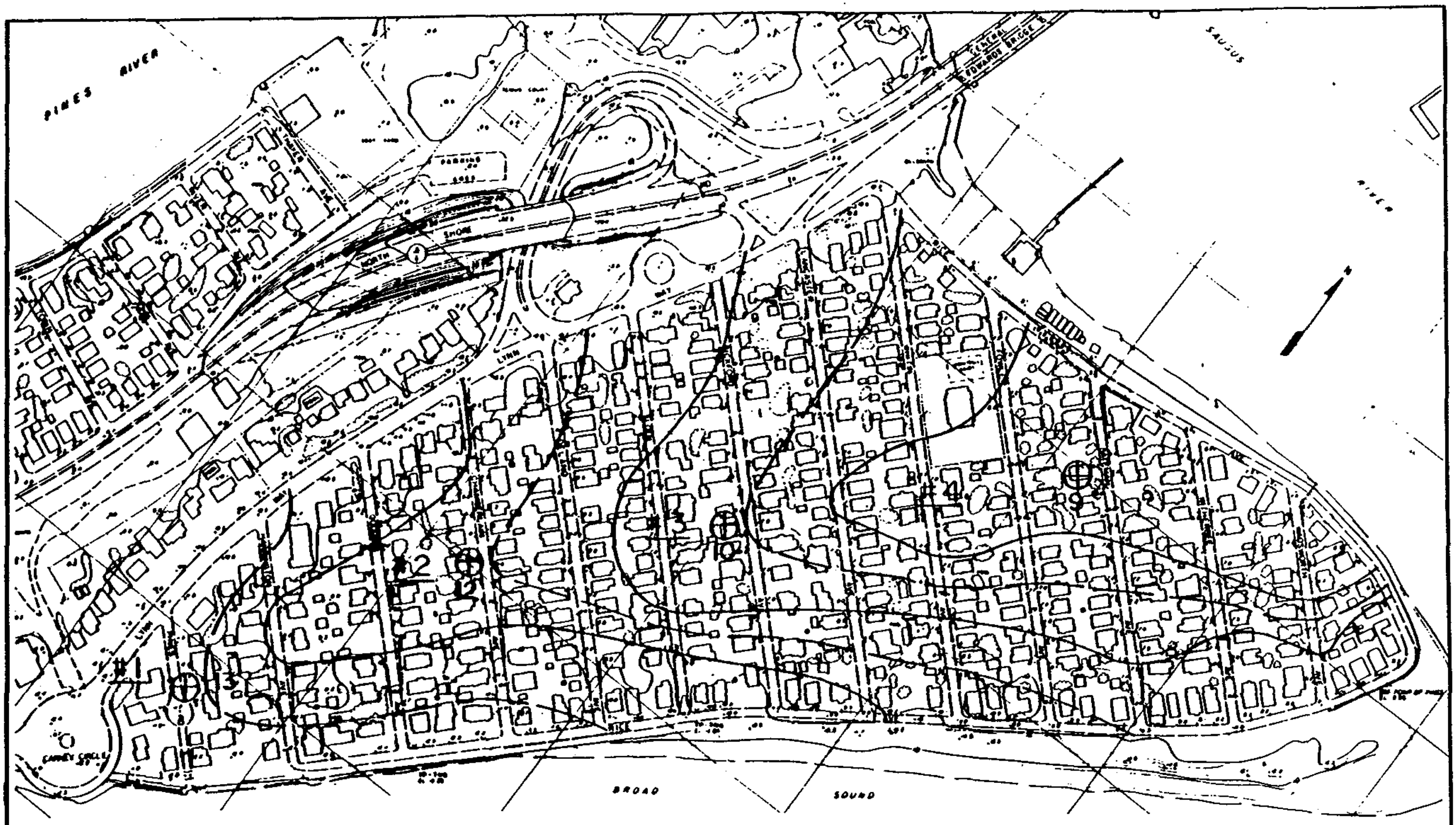
With the proximity of Revere Beach, the need for recreational facilities in Point of Pines is very localized. Limited public access to the water restricts current recreational use. At low tide, some beach area is exposed. There is easy access along the shoreline making it possible to walk the entire length of the Point of Pines' shoreline. At high tide; however, access is greatly reduced particularly at the southerly end near Carey Circle where water actually abuts the seawalls and revetment.

The coastal waters of Revere, including Broad Sound, are subject to highly variable water quality conditions. Water quality samples taken by the Metropolitan District Commission (MDC) each summer at Revere Beach have usually been rated at less than 100 MPN (most probable number of E. Coli per 100 ml). This rating makes the area suitable for swimming. However, Lynn Harbor, which adjoins Broad Sound to the north, is the location of a raw sewage outfall which discharges 20 million gallons per day. The discharge at Lynn, as well as similar discharge at Nahant to the northeast, make the Broad Sound area unsuited for harvesting of shellfish.

(7) Social Environment

. History. The Revere area was originally settled by Europeans about 1626. Revere, originally called Rumney Marsh, joined the city of Boston in 1634, at which time land was given to seven families who established farms and homes there. In 1739 the community became part of Chelsea. The area was called North Chelsea in 1846, and was changed to Revere in 1871.

"Rumney Marsh" supported a farming community until the 19th century. Completion of the Boston, Revere Beach and Lynn railroad (the "Narrow Gauge") in the 1870's signaled rapid development of the Revere Beach area as a summer resort community. Small summer homes were built in the vicinity of the beach and a hotel, a great pier, dance halls and other recreational facilities once dominated the area. Not only did the railroad make it possible for people to travel to Revere for recreation, but it also made it possible for people to reside in Revere and work in Boston and other communities. Residential development began to occur all along the rail rightof-way.



LEGEND

#2 ZONE NUMBER

——— INDEX LINE EL ⊕10

——— LIMIT OF ZONE

SCALE

100 0 100 200 300 400

500 FOOT GRID BASED UPON MASSACHUSETTS RECTANGULAR GRID SYSTEM

NATIONAL GEODETIC VERTICAL DATUM OF 1929

DATE OF PHOTOGRAPHY - 2-7-81
CONTOUR INTERVAL - 2 FT.

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS

COASTAL FLOOD PROTECTION
POINT OF PINES, REVERE
MASSACHUSETTS
INDEX ZONE LIMITS

PLATE 3

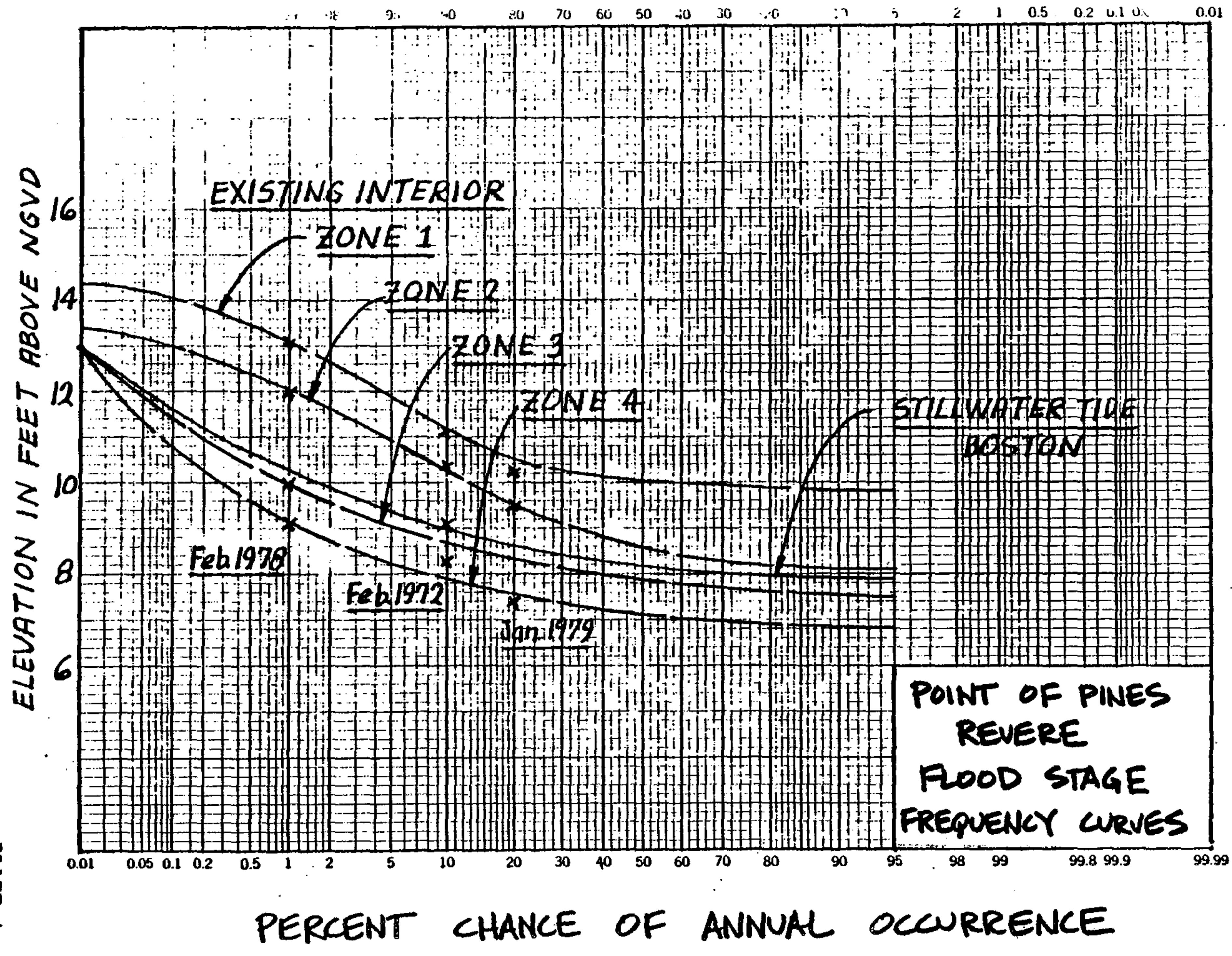

EXISTING INTERIOR
ZONE 1
ZONE 2
ZONE 3
ZONE 4
STILLWATER TIDE BOSTON
Feb.1978
Feb.1972
Jan.1979
ELEVATION IN FEET ABOVE NGVD
16
14
12
10
8
6
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.8
99.9
99.99
POINT OF PINES
REVERE
FLOOD STAGE
FREQUENCY CURVES
PERCENT CHANCE OF ANNUAL OCCURRENCE

PLATE 4

Realizing the potential, a fantasy-type amusement area called "Wonderland Park" was developed in 1906, adjacent to the railroad and west of the residential neighborhood. This provided the impetus for further development of the region.

The beach and amusements flourished as a major attraction until the 1940's, when the quality of the beach and structures began to decline. Increasing public mobility, changing tastes and recreational attitudes, and falling profits all contributed to this downward trend. The deteriorated condition of Revere Beach, as well as the growing need for quality public recreation areas within the metropolitan region, has forced a renewed interest in reversing this pattern and reclaiming one of Boston's most accessible natural resources.

The residential growth of Revere continued and reached another period of rapid development in the Post-World War II period of the 1950's. Most of the housing in the western and northern sections of Revere was constructed during this period.

Because Revere is so close to Boston, heavy traffic conditions, particularly in the peak commuter hours, are a daily characteristic of the city. Several major highways and arteries pass through Revere providing direct access to the Boston central business district area.

As in the case of many older urban centers, Revere is coping with a variety of problems including a declining youth population, deteriorating public utilities, neglected neighborhoods, older housing in need of rehabilitation, and a declining tax base.

. Population and Economy. The city of Revere is considered to have a stable population base with regards to total inhabitants. Over the 30-year period between 1950 and 1980, Revere netted a population increase of only 15 percent.

TABLE 1
CITY OF REVERE
PAST POPULATION

1950	1955	1960	1965	1970	1975	1980
36,800	39,600	40,100	42,400	43,200	41,300	42,400

Population projections compiled by the Metropolitan Area Planning Council (MAPC) indicate that Revere's historic trend of a stable population will continue (see below). No great change is expected for the next 100 years.

TABLE 2
CITY OF REVERE
PROJECTED POPULATION

1990	2000	2020
42,600	43,500	44,500

Significant changes in the age structure of Revere's population did occur between 1950 and 1970. During that 20 year span, the population growth of the 65 and older bracket increased by 70 percent while the overall population grew only 18 percent. During the same time, Revere lost residents between the ages of 25 and 44. It appears then that the younger, more active, and prosperous members of the population have been replaced by residents 65 years of age and older.

The Point of Pines study area is one of ten neighborhoods within the city. The Point of Pines population for 1975 was about 1200, averaging nearly 20 people per acre. There is little room for any significant future development, with this estimated density expected to remain the same.

Revere offers a variety of mixed land uses, but is predominantly residential. The census figures for 1980 reveal that there are 17,176 housing units in the city. This is an increase from the 14,635 units in 1970. Based on city estimates for January 1980, 40 percent of the total housing units were considered substandard and deteriorated. Approximately 54 percent of total housing units are owner occupied, 38 percent of which are single family units. Almost two-thirds of the housing was built prior to 1940.

Many Revere residents work in Boston or its suburbs. The Massachusetts Division of Employment Security estimates that there was about a 6.3 percent unemployment rate statewide in 1981. This correlates with a 1981 Revere labor force estimated at 23,000 people - about 21,200 of whom were employed. The unemployment rate for Revere in 1981 was 7.9 percent.

The reported number of available jobs in Revere can employ only 40 percent of the city's labor force. Therefore, a minimum of 60 percent of the labor force works outside city limits (not adjusting for commuters who work in Revere and live elsewhere, or for part-time jobs which make up full-time equivalents). This illustrates that Revere is basically a commuter suburb.

In 1980, 595 firms in Revere reported to the Massachusetts Division of Employment Security an average employment of 7,644 people. Employment in Revere is heavily concentrated in the wholesale and retail trade sections - accounting for over 40 percent of Revere's employment total. Service establishments and governmental agencies each employ about 20 percent of the labor force. This is explained both by Revere's character as a residential community and a resort and entertainment center that includes Revere Beach, Suffolk Downs Race Track, and Wonderland Dog Track. Manufacturing plays a minor economic role.

The median income for 1980 was approximately $14,800. The table below offers a comparison of the total number of people employed in Revere per industry for 1969 and 1979.

TABLE 3
EMPLOYMENT IN REVERE
1969 and 1979

Category	1969	1979
Agriculture, Forestry, Fishing	54	20
Mining	0	0
Construction	361	209
Manufacturing	630	477
Transportation, Communication Utilities	171	434
Trade	2,839	3,435
Finance, Insurance, Real Estate	44	295
Service	1,461	1,470
TOTAL	5,560	6,340

Source: Massachusetts Division of Employment Security, December 1980

An examination of Revere's finances illustrates that Revere does not have a surplus of funds available for new flood protection facilities and drainage improvements. Any future major improvements or flood protection facilities would probably require a bond issue, substantial State and/or Federal aid. Without Federal participation, it is highly doubtful that local interests would provide flood protection measures on their own.

(8) Cultural and Natural Resources

Man entered New England in the wake of the retreating glaciers, and the earliest known cultural site in this immediate region is the Bull Brook site near Ipswich (about 20 miles to the northeast of Revere), dated around 9000 B.C. Many prehistoric sites of more recent age have been found in this region. The earlier sites represent people with a hunting, fishing, and gathering adaptation. Limited agriculture began to be practiced about 1000 AD. Boston Harbor may have been one of the environmentally richest areas in New England, with its abundant coastal, estuary, river, and land resources. The long span of occupation and considerable prehistoric population is reflected in the wealth of archaeological sites that have been found here. Unfortunately, many of these sites have been destroyed by the activities of the historic period. A number of burial sites of the late prehistoric and contact periods have been found over the years along Revere Beach, primarily during construction projects.

There are no historic sites within the study area listed in the National Register. Due to periodic ground disturbance over the years, adverse effects on cultural resources from any proposed project appear unlikely. In fact, modern demolition and construction in the vicinity has obliterated most of the 19th century resort development and any new flood protection measures are unlikely to affect any significant historic resources. However, consultation with the Massachusetts Historic Commission indicates that an archaeological survey may be required before a finding of effect can be determined.

The assets of Revere are numerous, beginning with its location. Situated just north of the city of Boston, Revere has direct highway and transit access to every portion of the metropolitan region. Five major highways pass through Revere, linking the city to the northern portions of Massachusetts and New England, and south to Boston and Interstate Routes 95 and 93. The Massachusetts Bay Transportation Authority's (MBTA) Blue Line, which terminates in Revere at the Wonderland Station, connects the three Revere stops to Logan International Airport, downtown Boston and the other MBTA transit lines. Although "run-down", the existing land uses are being improved by the locals. The qualities and values of seashore property is the study area's principal resource.

(9) <u>Land Use</u>

Revere has approximately 7 miles of beach and ocean shoreline. Revere Beach, owned and operated by the MDC, was the first public beach in the country. The beach is still a major recreational resource for the city and the entire metropolitan region. Although the city is densely developed, much of the area is still characterized by open water and tidal marsh. The Pines River forms approximately 500 acres of marshland just west of Revere Beach, Point of Pines and Oak Island.

This Saugus/Pines River marsh is the largest tract of undeveloped land in Revere. Pressures for filling and developing the marsh increase daily. The Seaplane Basin in north Revere was partially filled in preparation for construction of Route I-95. Although the highway construction was halted years ago, the fill material remains.

Revere has a land area of approximately 8 square miles or 4,000 acres. Three thousand acres of this area is buildable land, of which 83 percent has been developed primarily for residential use. The remaining 1,000 acres of land is not suitable for development. Revere's growth over the years has been as a residential, entertainment centered community with little land developed for major industrial use. Any significant new development would occur primarily as replacement or conversion of structures on vacated land. The table below displays the present land use pattern in Revere.

TABLE 4
REVERE LAND USE

Category	Percentage
Residential	46.9
Commercial and Industrial	12.5
Streets and Transportation	33.1
Recreation	7.5

Source: Environmental Assessment, Revere Master Plan, 1978.

B. WITHOUT CONDITIONS

This section describes the most probable future condition for the city of Revere. These projections assume no new Federal participation in water resources projects in the Point of Pines area. Alternative measures presented elsewhere in this repot are assessed and evaluated by comparing the "with" to the "without project" condition.

Revere has experienced a very slow rate of growth over the past 30 years. In fact, 1980 census figures indicate that the city lost some 800 people between 1970 and 1980. Population projections predict minimal growth for the city through the year 2020 (see Tables 1 and 2). The population of Point of Pines is also expected to remain nearly constant throughout the planning period. Some residents have converted properties to multi-apartment dwellings, allowing for a slight population increase.

Due to the periodic severe flooding, many inhabitants have installed floodproofing measures. The Massachusetts Coastal Floodproofing Program was funded by the Department of Housing and Urban Development, which provided grants and technical advice to low and moderate income homeowners. Some homes in Revere have received financial assistance in raising homes or utilities as a flood damage reduction measure under this program. Any significant flood protection or damage reduction measure, currently in place, was considered in economic analyses.

(1) Development

Revere is currently considering a number of economic revitalization plans. The objectives of the city's general development strategy as outlined in their Recreation Recovery Action Plan include the stabilization of neighborhoods and the tax base; the expansion of industrial and commercial efforts; development of the city's 3-mile long beachfront, its greatest asset; and the overall improvement of public facilities.

Future plans directly related to the study area include development of the Revere Beach plan, a large scale redevelopment plan involving a private developer, the MDC, and the city of Revere. The plan involves new apartment and condominium complexes, improved traffic patterns, the upgrading of Wonderland Station and existing parking facilities and a commercial area between the complexes. Construction of a new waterfront park by the MDC along the site of the former amusement complex has already been started.

Point of Pines has been an established residential area since the late 1800's. There is little available space for new growth and development. The area will continue to experience almost yearly economic losses due to flooding without protection.

(2) Flood Threat

As evidenced by the severe flooding caused by the February 1978 storm, and the losses suffered on an annual basis, the study area is insufficiently protected against flooding by any existing facilities. In fact, the extent of flooding at Point of Pines during this "Blizzard of 78" - an event estimated to have a 1% chance of occurring annually, was such that it inundated the entire study area!

The city remains very much concerned about the flood situation. Without flood protection, occurrence of a storm the magnitude of the "Blizzard of '78" would mean significant damage in Point of Pines as well as other coastal neighborhoods. It is assumed that growth will be controlled within the flood plain as required with participation in the National Flood Insurance Program and the 1972 Clean Water Act. This, together with an analysis of Revere's finances, implies that the city would not develop flood protection without Federal participation.

Under the Flood Insurance Program flood losses would be only partially covered - as there are no existing provisions for compensation for non-physical losses, such as expenses for lodging during dwelling repairs or loss of income or profit while a commercial or manufacturing firm is temporarily closed. Other emergency expenses not covered include evacuation, food, clothing, restoration of public utilities and clean-up operations. Undoubtedly, some residents would incur permanent losses in savings and irrespiaceable personel belongings. Flood insurance alone merely indemnifies property owners for flood losses, but does not reduce physical damages.

However, this does not comprehensively address the flood hazards of waves overtopping the existing measures and the many homes and families who suffer losses periodically. Point of Pines will continue to be flooded on almost a yearly basis, without protection against severe ocean storms. The risk to residential property can only be diminished by a small amount due to individual floodproofing measures.

C. PROBLEMS, NEEDS AND OPPORTUNITIES

The 1980 U.S. Census reported 17,163 residential structures in Revere. In the 1978 storm about 1555 homes, or approximately 9 percent, were damaged. Estimated flood damage for a recurrence of the 1978 flood would be quite severe. Total losses to residences alone represent over 70 percent of the damage throughout Revere.

The 1978 flood, used as the index for measuring the severity of damages in Revere, came directly after a severe blizzard. When the damage survey specialists from the Army Corps of Engineers assessed damages, they separated these flood losses into two types—physical and nonphysical. Physical losses include such things as damage to structures and their contents. Nonphysical losses take into account a wide variety of other losses attributable to flooding, such as loss of work and costs of temporary housing and food.

The flood of record at Point of Pines was that resulting from the Blizzard of 1978. This storm produced an approximate 100-year event (a storm with a 1 percent chance of occurenc in any given year) with a maximum interior flood elevation of 13.0 feet NGVD. In fact, flood damage was extensive throughout Revere, with Point of Pines being one of many neighborhoods damaged. Recurring losses for the 1978 storm at Point of Pines are about $5.3 million affecting over 360 structures with an approximate population of 1200. In some cases (18 percent of the total population) people were unable to return to their homes in 1978 for over 1 week.

The recurring losses for Point of Pines are shown in the following table. Plate 4, shown earlier, depicts the relationshiop between stillwater tide levels surrounding the study area and the associated stages of flooding within its interior portion.

TABLE 5
RECURRING LOSSES
POINT OF PINES

% Chance of Annual Occurence	No. of Structures Affected	Losses ($Million) (Jan 84 PL)
10	320	3.1
5	342	4.0
2	360	4.9
1	363	5.3
0.2	366	6.8
SPN	369	10.3

Other expenses are associated with severe flooding in addition to the measured damages previously discussed. These costs can be quite large and include the expenditures by the over 20 Federal, State, and local emergency assistance programs that are put into action each time. These expenses result from emergency activities prior to, during, and after a flood; such as: flood emergency centers, communication facilities not otherwise needed, temporary evacuation assistance, flood fighting materials and personnel, additional police and fire protection, and public clean-up. At least some of these expenditures would be prevented by more protection. Table 6 provides just a partial list of the agencies involved in emergency operations during the 1978 storm and in the subsequent rehabilitation operations.

TABLE 6
ORGANIZATIONS AND ACTIVITIES
EMERGENCY OPERATIONS - REVERE 1978

1. Housing and Urban Development (HUD) - Temporary Housing, Federal Insurance and a Minimal Repair Program

2. Small Business Administration (SBA) - Home, Personal and Business Loans

3. Department of Labor (DOL) - Disaster Unemployment Insurance

4. Department of Agriculture (DOA) - Food and Nutrition Service (Food Stamps) and the Farmers Home Administration

5. Federal Disaster Assistance Administration (FDAA)

6. Internal Revenue Service (IRS) - Casualty Loss

7. Community Services Administration (CSA) - Grants to local communities and the Action Agencies for Food and Fuel

8. Health, Education and Welfare (HEW) - Offices on Aging Grants for Special Needs of the Elderly

9. Federal Highway Administration (FHA) - Federal Aid for Roads and Highways

10. U.S. Army Corps of Engineers (CE) - Emergency Operations and Rehabilitation of Flood Projects

11. U.S. Army, Massachusetts - Massachusetts National Guard

12. U.S. Economic Development Administration (EDA) - Massachusetts Disaster Recovery Team

13. Mission Assignments, Massachusetts (Reimbursed by FDAA) - U.S. Army Corps of Engineers, Environmental Protection Agency, Federal Aviation Agency,.Federal Highway Administration, and the General Services Administration

14. U.S. Coast Guard, Massachusetts (USCG) - Aids to Navigation

An impact associated with severe flooding and extensive property damage is the psychological and emotional pressures exerted upon individuals during such a crisis situation. "Project Concern" was instituted in temporary response to such needs resulting from the Blizzard of 1978. It provided crisis counseling for such problems. The program was sponsored by the National Institute for Mental Health and the Federal Disaster Assistance Administration and implemented by the Massachusetts Departments of Mental Health and Research for Social Change, Inc. Over 415 people from Revere received professional help from case workers. Residents' problems encountered by the staff included stress, phobic reactions, anxiety, displacement and personal loss and grief.

Details regarding project economics including flood losses and benefits are discussed later.

Flooding has been a serious problem at Point of Pines for many years as evidenced by the construction of the existing seawalls and rock berms to protect the area. The existing flood protection measures, including the natural sand dunes, are not effective. Interior drainage is handled only by a small pumping station which was not designed for, and has been proven inadequate in major coastal flooding situations. There is a need to reduce damages to an acceptable level, measured economically, that are caused by coastal flooding. Implementation of an improved flood protection system would also provide an opportunity to protect, or enhance, the values and qualities of the study area's seaside location.

III. PLAN FORMULATION

The formulation and analysis of alternative plans is based, in part, on careful review of the existing situation and the problems, needs, and opportunities of the study area. At Point of Pines, alternative measures were investigated to address the problem and opportunity statements outlined earlier: reduce coastal flood damage and protect and enhance the values and qualities of the shorefront environment. The associated probable social and environmental impacts of each measure were evaluated, as well as its economic and engineering feasibility, and public attitudes.

Of course, all alternative plans were formulated with regard to completeness, effectiveness, efficiency and acceptability. A project is complete when its design assures accomplishment of the intent of its implementation. For example, a plan to prevent flooding from one source should not be cause to a flood problem from another source or to another area.

Effectiveness and efficiency of a particular plan can be measured economically. The amount of damage reduction afforded by a project is one way to gauge effectiveness. Efficiency can be expressed by the Benefit-to-Cost Ratio (BCR); that is, benefits expected with project implementation divided by its cost. When the BCR is greater than unity, the project is economically feasible.

Finally, acceptability is the ultimate criteria that a plan must achieve for endorsement by a local sponsor and selection for recommendation. Any alternative solution to the identified problems and opportunities must have the support and endorsement of the local interests before recommendation. However, measurement of acceptability may range from affordability of the items of cooperation by the local sponsors, to the level of environmental impact associated with the project. This section describes the alternatives and plans that were studied and the iterative process used to screen them.

A. RATIONALE

The frequency and depth of potential future flooding was developed from an analysis of historic flood information gathered from residents, consideration of the topography and the application of hydrologic engineering judgement. For example, the record 7 February 1978 event produced experienced flood levels generally ranging from 13.0 to 9.0 feet NGVD from south to north respectively in Point of Pines. Similarly, based on available information and interviews, the 19 February 1972 and 21 January 1979 events also produced very serious flooding. This is graphically displayed on Plate 3. The interior flood elevations of the Standard Project Northeaster (SPN) or flood range from 13.0 feet to 14.4 feet NGVD and the event with a 0.2 percent change of occurrence annually is 10.2 to 13.8 feet NGVD. The 7 February 1978 event has an estimated chance of occurrence in any given year of 1 percent.

Where damages from large floods would be catastrophic, the Standard Project Flood (SPF) is the goal for the level of protection. The SPF is a flood that might be expected from the most severe combination of meteorological and hydrological conditions that are considered reasonably characteristic of the region involved, excluding extraordinarily rare combinations. This policy is particularly applicable to projects involving urban areas.

In the case of Point of Pines in Revere, the stillwater tide levels and waves produced by a very severe northeast storm would be the criteria defining the SPF -- that is, the SPN. Since the SPN tide level has never been formally developed an approximation of this level was used for this stage of study. Extensive computer modeling at the Corps' Waterway Experiment Station (WES) has been intiated for the Revere area as part of the neighboring Roughans Point Flood Protection Study. The detailed plans and specifications for Point of Pines will be coordinated with that effort.

The complete record (1922 - present) of the National Ocean Survey (NOS) tide gage at Boston Hrabor was analyzed to determine the maximum recorded storm surge (observed level minus predited level). This analysis was performed by the U.S. Weather Bureau for data up to 1960 and by the National Weather Service from then to the present. The maximum surge was found to be 5.1 feet.

The maximum surge of record was then added to the maximum probable high tide, resulting in an approximate SPN tide level of about 13.0 feet NGVD. Such an estimate appears reasonable when compared to the 6-7 February 1978 storm tide level of 10.3 feet NGVD, which is the greatest observed tide in Boston and which has a 1.0 percent chance of occurrence annually (100-year recurrence interval).

Wave overtopping for tidal floods with selected maximum tide levels were developed using maximum likely waves and a design onshore wind speed of 60 MPH. This was done for both existing and proposed protection. The results were then used in examining interior flooding for alternative solutions, leading to development of modified interior stage vs. frequency curves. Hydrologic and hydraulic details are included in Appendix A.

Coastal flooding in the Point of Pines area presently occurs first in the north end at a relatively low area near the Point of Pines Yacht Club. Residents report that water flows into the street at this location during minor storms and drains back out to sea. However, during severe storms, like the February 1978 event, the tidal inflow is "overwhelming", resulting in extensive flooding. This low area would experience more frequent and greater overtopping except that it faces the Saugus River and is protected from the direct attack of ocean waves.

With increasing storm intensity, the second point of overtopping is reported at the southern end of Point of Pines near Carey Circle. This area is exposed to the open ocean and receives the brunt of wind induced ocean waves. Overtopping waters in the south migrate to the north causing shallow flooding throughout the length of Point of Pines along its natural drainage course. Some wave overtopping in the Carey circle area also reportedly flows north on the Lynnway and then enters Point of Pines from the westerly back side.

Lastly, during major tidal storms there is wave overtopping generally throughout the length of the existing line of protection along Rice Avenue. Because of the condition of the sand dunes, they are vulnerable to breeching. During the '78 flood, water entered Point of Pines from here also.

B. SCREENING OF ALTERNATIVES

Measures addressing coastal flood damage reduction fall into two general categories. Some modify the extent of flooding by altering the natural environment; such as breakwaters, seawalls, revetments, etc. Others address flood damage vulnerability through flood plain regulations, flood insurance, floodproofing, relocation and/or acquisition.

ALTERNATIVE FLOOD DAMAGE PREVENTION MEASURES

Modifying Floods	Reduce Vulnerability
Breakwaters	Floodproofing
Seawalls & Dikes	Flood Warning and Evacuation
Revetments	Flood Plain Regulations
Beach Restoration	Flood Insurance
Sand Dunes	Public Acquisition of Flood Plain Land

Below is a brief description and a summary of the study's findings for each type of measure investigated for Point of Pines.

(1) Breakwaters

A breakwater is a structure protecting a shore area, harbor, anchorage or basin from wave attack. Beaches and flood prone areas along the coast can be protected by a structure that reduces the wave energy reaching the shore. Breakwaters are generally some variation of an offshore rubble stone mound structure, adaptable to almost any depth and can be exposed to severe waves. In some instances, both cellular steel and concrete caissons have been used as construction materials.

Breakwaters can have both beneficial and detrimental effects on the shore. Offshore breakwaters are usually more costly than onshore structures, such as seawalls or revetments. The elimination of wave action not only provides protection but reduces the movement of sand along the shore and nourishment of the downdrift beaches also.

The cost of a permanent breakwater located offshore was found to be prohibitive, with estimated costs far in excess of benefits attained. In addition, floating breakwaters to intercept incoming waves were also determined as not being implementable. Such a breakwater is not effective when subjected to a design wave with a period of 4 seconds or more, or a wave height greater than 4 feet (Technical Report HL-80 Floating Breakwater). The design wave height for Point of Pines is 9.0 feet. Thus, for these reasons both permanent and floating breakwaters were dropped from consideration early in the study.

(2) <u>Seawalls and Dikes</u>

Protection of shore development can be accomplished by constructing wave-resistant walls of various types. Seawalls may have vertical, curved or stepped faces. While seawalls may protect development, they can also create a problem. The downward forces created by waves striking the wall can rapidly remove sand in front of the wall. A stone apron is often necessary to prevent this excessive scouring and undermining.

A seawall constructed on piles with sheet pile cutoff walls would be effective in minimizing tidal flood damage to development behind the wall. However, without widening and raising the beach berm in front of the wall, wave action would accelerate the loss of beach material. Therefore, any plan which considers seawall construction must include measures to protect the beach. Beach berm construction and nourishment, along with a seawall, can be an effective tidal flood protection measure.

Earth dikes, or levees, can be built around vulnerable structures or groups of structures, or in areas along the shore where wave action will not undermine the embankment. Earth dikes would need stone slope protection to prevent scour from small waves and tidal drawdown, however.

Alternatives involving seawalls and dikes were found to be practical and implementable. These measures warranted further consideration.

(3) <u>Revetments</u>

Sloping revetments armor the seaward face of a shoreline with one or more layers of stone or concrete. This sloping protection dissipates wave energy, with a less damaging effect on the shore. Two types of structural revetments are used for coastal protection: the rigid, cast-in-place concrete type and the stone armor unit type.

Like seawalls, these were found feasible and subjected to a more detailed analysis. Alternatives involving revetments are described in following sections.

(4) Beach Restoration and Nourishment

Beaches are very effective in dissipating wave energy. When maintained to adequate dimensions, they can afford protection for the adjoining backshore. When conditions are suitable, long reaches of shore may be protected by artificial nourishment. The resultant widened beach also has added value as a recreational feature.

The existing sand dune system at Point of Pines makes beach restoration and nourishment a particularly attractive flood protection measure. In addition, as mentioned above, such an approach also provides toe protection for more permanent flood damage reduction structures, while affording a recreational resource. This measure was thus also chosen for more detailed evaluation.

(5) Sand Dune Development

Except for sections of the shoreline where some structural protection has already been constructed, the existing dune line is more or less continuous along the exposed shoreline. During major floods, the dune line is sometimes breached or flanked, and flooding takes place behind the dunes. Sand fences in various areas along the shoreline can be very effective in trapping sand to build up low points, strengthen narrow sand ridges, and generally build up any existing dunes. Once the sand dunes are built up to the desired height, they should be stabilized and protected by vegetation.

Use of American beach grass to stabilize and enhance protective dunes has been successful at several sites on the Atlantic coast. The photograph on the following page depicts a typical planting operation after the dunes have been shaped with a bulldozer. It also shows the same area after the beach grass has reached maturity.

With proper fertilizing techniques, the grass can be induced to produce an extensive root system from which additional plants will rise to the surface. Continued protection can only be afforded if recommended fertilization and cultivation procedures are observed. Controlled access is essential for maintenance of dunes. This can be accomplished with wooden walkways or with rolled clay pathways over the dunes. Although the growth is dense, it is sometimes necessary to erect fences to prevent random access to the beach and needless erosion.

This measure falls into the same general category as beach restoration and was included in further detailed alternative analysis.

(6) Floodproofing

This encompasses several techniques for preventing damages due to floods, requiring action both to structures and to building contents. It involves keeping water out, as well as reducing the effects of its entry. Such adjustments can be applied by the individual, or as part of a collective action, either when buildings are under construction or during remodeling. They may be permanent or temporary measures.

Floodproofing, like other methods of preventing flood damages, has its limitations. It can generate a false sense of security and discourage the development of needed flood control and other actions. Indiscriminately used, it can tend to increase uneconomical use of flood plains resulting from unregulated flood plain development. Each measure must be evaluated for its specific application in the reduction of flood damages, and only then can it be decided if that particular measure is feasible -- physically or economically.

Floodproofing measures can be classified into three broad categories. First are permanent measures which become an integral part of the structure or land surrounding it. Second are temporary or standby measures which are used only during floods, but which are constructed and made ready prior to any flood threat. Third are emergency measures which are carried out during flood situations in accordance with a predetermined plan. In recent years, floodproofing has come to be known as a "nonstructural" measure. "Structural" measures are traditionally associated with major civil flood control works.

Typical nonstructural measures include closures for openings (doors, windows, etc.), waterproof sealants for walls and floors, utility valves to prevent backflow of sewer and plumbing facilities, and sump pumps. Another technique is raising existing structures above design flood levels.

Within an existing or group of structures, damageable property can often be placed in a less vulnerable location or protected in-place. Furnaces and appliances can be protected by raising them off the floor. Damageable property can be moved from lower to higher floors, or other less flood-prone sites. Important mechanical and/or electrical equipment can be floodproofed by inclosing them in a watertight utility cell or room.

A consideration that must be included is that residual damage to both the structure and contents will remain even when the most vulnerable property is rearranged or protected. Measures such as these are usually considered when other measures are either not physically or economically feasible, or the depth of flooding is relatively shallow.

Elimination of flood damages can also be accomplished by relocation of existing flood-prone structures and/or contents. There are basically two options for removing property to a location outside the flood hazard area. One is to remove both structure and contents to a flood-free site; the second is to remove only the contents to a structure located outside the flood hazard area, and demolish or reuse the structure at the existing site.

Preliminary investigations indicated floodproofing as inappropriate for the Point of Pines area. Flooding can be deep, rendering many of the above measures ineffective. In certain cases, isolation would result necessitating evacuation. In addition, floodproofing does not provide the comprehensive solution acceptable to the public. Much damage would remain despite implementation of such measures. For these reasons, floodproofing was not selected for more detailed consideration. A more detailed summary of nonstructual analyses conducted for this study is offered in Appendix G.

(7) Flood Warning and Evacuation

Flood forecasts, warning and evacuation is a strategy to reduce flood losses by charting out a plan of action to respond to a flood threat. The strategy should include:

- A system for early recognition and evaluation of potential floods.

- Procedures for issuance and dissemination of a flood warning.

- Arrangements for temporary evacuation of people and property.

- Provisions for installation of temporary protective measures.

- A means to maintain vital services.

- A plan for postflood reoccupation and economic recovery of the flooded area.

Flood warning is the critical link between forecast and response. An effective warning process will communicate the current and projected flood threat, reach all persons affected, account for the activities of the community at the time of the threat (day, night, weekday, weekend) and motivate persons to action. The decision to warn must be made by responsible agencies and officials in a competent manner to maintain the credibility of future warnings.

An effective warning needs to be followed by an effective response. This means prompt and orderly evacuation and/or action. This includes:

- Establishment of rescue, medical and fire squads.

- Identification of rescue and emergency equipment.

- Identification of priorities for evacuation.

- Surveillance of evacuation to insure safety and protect property.

The city of Revere, at the present time, does not have a structured flood warning and evacuation plan. The city does have an Emergency Operational

Plan which was designed to provide general guidance for necessary actions during a disaster. This plan addresses the need for maintenance of these vital services. However, it does not contain specific actions to be taken during a flood episode. Early recognition and warning of a potential flood episode can save lives and property if proper actions are taken.

The only method of warning residents is the Revere audible warning system administered by the Civil Defense, designed to warn of a possible military attack through a series of sirens. This system does not alert the public concerning the type of emergency or provide any guidance and instruction for the particular action. A provision should be added to the plan to allow for localized warning of residents in flood-prone areas either by house to house visits or by police cars patrolling the area. These areas should include not only those that will be flooded but also the evacuation routes.

Accomplishing the evacuation as smoothly as possible requires that specific routes and tight coordination between city departments is established. It is also necessary to insure that evacuees be provided with adequate food and shelter during the emergency. The shelters should have ample capacity, proximity to the areas so they can be reached quickly, and accessibility along routes that are safe from flooding.

In summary, Revere's emergency operations plan can be expanded, with minimal effort, to include:

- Development of a flood warning system
- Determination of safe evacuation routes
- Provisions of adequate emergency shelters
- Methods to provide vital services

Inclusion of these items into existing plans is recommended as part of any flood protection system. However, warning and evacuation alone does not prevent widespread flooding and the physical damage it brings. Because of the nature of Revere's flood problem, improving the plan is seen as primarily an administrative effort. Revere and its residents should maintain familiarity with the revised plan to insure its effectiveness if implemented.

(8) Flood Plain Regulations

Through proper land use regulation, flood plains can be managed to insure that their use is compatible with the severity of a flood hazard. Several means of regulation include: zoning ordinances, subdivision regulations, building and housing codes. Their purpose is to reduce flood losses by controlling the future and existing uses of flood plain lands.

Zoning regulates the use of structures and land, the height and bulk of buildings, and the size of lots and density of use. It is usually based upon some broad land use plans to guide the growth of the community. Subdivision regulations guide the division of large parcels of land into smaller lots for development. Subdivision regulations with special reference to flood hazards often (1) require installation of adequate drainage facilities, (2) require filling of a portion of each lot to provide a safe building site at an elevation above the selected flood height, and (3) require the placement of streets and public utilities above a selected flood protection elevation. Building and Housing Codes neither regulate where development takes place nor the type of development, but rather specify building design and materials.

Point of Pines is a long-standing neighborhood of the city of Revere. For all practical purposes, it has been developed to the maximum extent possible. Established regulations are consistent with wise flood plain use. Any new structures are, therefore, not expected to significantly influence project economics. Enforcement of these flood plain regulations is obviously encouraged; however, further examination of this measure as an alternative solution to the problems and opportunities identified earlier is not warranted.

(9) Flood Insurance

Flood insurance is not really a flood damage reduction measure; rather it provides protection from financial loss suffered during a flood. The National Flood Insurance Program was created by Congress in an attempt to reduce, through more careful planning, annual flood losses and to make flood insurance protection available to property owners. Prior to this program, the response to flood disaster was limited to the building of flood control works and providing disaster relief to flood victims. Insurance companies would not sell flood coverage to property owners, and new construction would often overlook new flood protection techniques.

The National Flood Insurance Program is conducted by the Federal Insurance Administration (FIA) under the direction of the Federal Emergency Management Agency (FEMA) -- formerly the Department of Housing and Urban Development, Flood Insurance Administration. The program provides local officials with a usable tool in protection of their flood plains. A flood-prone community, once on the regular program, must enact flood plain zoning in accordance with minimum guidelines established by FEMA. Revere is such a community. Failure to enact or enforce such legislation could be penalized by forfeiture of all Federal funding assistance.

Flood insurance is an option for all owners of existing buildings in a community identified as flood-prone. It is compulsory for all new buyers of property in the FEMA designated base flood plain where Federally insured mortgages or mortgages through Federal connected banks are involved.

In order to qualify, a community must adopt preliminary management measures, including floodproofing for all proposed construction or other development in the flood plain. They must be reviewed to assure that sites are reasonably free from flooding. All structures in flood-prone areas must be properly anchored and made of materials that will minimize flood damage. New subdivisions must have adequate drainage, and new or replacement utility systems must be located to prevent flood loss.

Without implementation of a flood damage reduction system, the financial losses associated with flooding will continually be a burden. It is not economical, nor wise for the government, both State and Federal, to continually provide assistance. Personal assests are limited. Like other flood plain regulations, use of flood insurance is encouraged. However, it also does not reduce the physical damage and social disruption caused by a flood. Since all new development would be required to elevate at or above the base flood (an event having a 1 percent chance of occurrence annually), and because of the extent of existing development, further study of flood insurance is not appropriate.

(10) Public Acquisition of Flood Plain Land

Public control over the flood plain may be obtained by purchasing the title or some lesser rights such as development or public access rights. Acquisition of the title is better suited for undeveloped or sparsely developed land in the flood plain. It is a very desirable means, however, of protecting and/or providing for environmental and wildlife protection, public open space and recreation or other purposes.

If such a measure were to be applied to Point of Pines, acquisition rather than easement would be required due to the nature of the flood problem. Due to extent of the flood plain, well over 50 percent of the homes would have to be included in such a plan. Acquisition of just 50 percent of the study area would cost over $14 million. This cost is far in excess of the damages prevented and the benefits achieved. For this reason, land acquisition was not considered a feasible alternative.

C. EVALUATION OF PLANS

The alternative measures surviving the initial screening process were subjected to further evaluation for purpose of comparison. They included:

- seawalls and dikes
- revetments
- beach restoration and nourishment
- sand dune development

All of these approaches are basically on-shore proposals that provide protection against coastal flooding by dissipating wave energy and reducing overtopping. It was determined that the single measures alone would not be appropriate due to the nature of the study area. Formulation of alternatives plans turned then to combinations of measures to optimize physical scale as well as to provide compatibility with the existing conditions.

The formulation process was broken down into different approaches to the protection for each of the three existing section types (revetment, sand dune, wall) and height optimization by varying the degree of protection, ranging from the 1 percent chance of annual occurrence event to the Standard Project level. In the case of Point of Pines, the Standard Project level event is that produced by a Standard Project Northeaster (SPN).

The plan selected for recommendation should maximize net economic benefits (NED plan), be acceptable to local interests and consistent with protection of the environment. Initial evaluations focused on combinations of concrete wall construction, stone revetments at various slopes, beach sand restoration and earth dikes (or levees).

Following are brief descriptions and expected impacts for each alternative plan considered. Reaches referenced within are as defined earlier.

(1) <u>Plan A</u>

Plan A1 considered a combination stepped seawall with curved face construction for all reaches of the study area. This plan would have replaced all existing protective measures.

It was found that this plan's scale is considered unacceptable to the public and thus, non-implementable. In fact, the destruction of the existing natural dunes in Reach E was considered environmentally unsound and most objectionable to the majority of interests. The prohibitive costs of this singular structural construction far outweighs resulting benefits, and was eliminated from further investigation based on economic feasibility.

Plan A2, calling for rock revetments along the entire Point of Pines shore, was also dismissed at this level from more detailed study. The sand dunes in Reach E and what little remaining beach along the Saugus River would be lost. Although its economic benefits were greater than the economic cost, its environmental impact through Reaches E, F and G make this solution inappropriate.

Similarly, Plan A3, beach restoration and sand dune development for all reaches of the study area would entail costs far in excess of expected benefits and was also dropped from more detailed study. The remainder of alternatives (Plans B-E) were combinations of different types of protective measures. A primary consideration was to preserve as much beach and natural area as possible, and utilize existing protective structures as advantageously as practicable.

(2) Plan B

This plan modified Plan A by calling for a stepped/curved-face seawall for Reaches A-D only. Reach E (the sand dunes area) would be renourished by beach grass plantings and sand replenishment. Construction of walkwalks over the dunes would allow for public access to the beach preventing erosion that threatens the intended level of protection.

The existing unanchored precast sections in Reach F would be stabilized by setting a structural footing under the sections and anchoring them to the footing.. Reach G would have an earth dike with a stone slope face running along the Saugus River shore on the seaward side of the yacht club.

Although this plan provided a high degree of protection, it was determined, like Plan A, to be undesirable and non-acceptable by the public due to its scale. A seawall for Reaches A-D would have to be very high to protect against wave attack and overtopping. The dike in Reach G would adversely impact the yacht club and result in some beach loss. Plan B was thus eliminated from further consideration as being nonimplementable.

(3) Plan C

Plan C included replacement of existing structures with a combination gravity retaining wall with stone revetment face for Reaches A-E. This plan would have eliminated the dunes in Reach E. Reaches F and G would be designed as in Plan B.

Although addressing the flood problem adequately, the elimination of the sand dunes and considerable reduction of beach area resulting from this plan disregards the study's other objective of protecting the values and qualities of the area's seaside location. Plan C was dropped in favor of other plans which consider both problem and opportunity statements.

(4) Plan D

Under Plan D, existing protective structures in Reaches A-D were left in place. Revetment sections, accompanied by sand replenishment, were added to provide the necessary wave energy dissipation. In an effort to preserve the existing sand dune/beach development along Reach E, restoration as in Plan B was included.

Improvements in Reach F would consist of replacing the existing precast seawall with a new precast concrete seawall 8 inches higher. Reach G's design also remained as in alternative B - an earth dike with stone slope protection along the Saugus River shore on the seaward side of the yacht club.

This scheme was found to be economically feasible. The dike design along the northern shore of the study area resulted in some loss to the existing beach and impacted the Yacht Club located there.

(5) Plan E

Plan E is similar to Plan D, except that the earth dike design for Reach G is replaced by a precast seawall along the property lines on the northern edge of Rice Avenue. In this manner, preservation of the existing condition is accomplished as much as practical while still providing the flood protection needed. This plan is economically feasible, acceptable to local interests, and consistent with protection of the environment.

D. COMPARISON OF PLANS

Plans D and E were the only alternatives warranting further study. These plans were subjected to a far more detailed analysis. The economics, both benefits expected and construction costs, were re-examined and updated. Discounting was made current using an interest rate of 8 3/8 percent for a 100-year period. How well each plan addressed the problems and opportunities were compared for the purpose of selecting one for recommendation. A set of criteria for each problem and opportunity statement was established to measure both plans accomplishments and impacts.

The problem and opportunity statements (identified earlier) are:

- Reduce damages caused by coastal flooding

- Protect and enhance the values and qualities of the shorefront environment

A number of indicators were chosen to measure how well the plans reduced coastal flood damage within the study area:

- Net Economic Benefits - annual benefits expected with implementation of the project in excess of its annual costs

- Benefit to Cost Ratio (BCR) - total project annual benefits divided by its annual costs. Economic feasibility is indicated when the benefits are greater than the costs, and the BCR is greater than unity.

- Annual Damage Prevented - total project annual benefits displayed as a percentage of annual flood loss without the project's implementation.

For protection and enhancement of the values and qualities of the shorefront environment, different criteria were used to measure the impacts of both plans:

- Net Beach Acreage - the difference in beach area above mean high water (MHW) with and without the project

- Impacted Structures - total number of buildings affected by construction of the project

• Aesthetics - Judgemental rating of aesthetic quality of the project, from highly desirable to not desirable

• Access - Affect on convenience of access to the beach area from the residential portion of the study area

• Fish and Wildlife - A statement regarding fish and wildlife resources impacted by project implementation

• Other Environmental Impact - A statement regarding expected project impacts on other physical characteristics of the study area

• Social Considerations - A statement regarding the expected project impacts on the inhabitants of the study area.

Table 7 presents a summary of the more detailed analysis of Plans D and E versus the criteria outlined above. Discussion of the comparison follows.

TABLE 7
PLAN COMPARISON

CRITERIA	PLAN D	PLAN E
A. Reduce Coastal Flood Damage		
1. Net Annual Economic Benefits (8-3/8%, 100 years)	1,239,000	1,173,000
2. Benefit-To-Cost Ratio (BCR)	4.8	4.0
3. Annual Damage Prevented (%)	97	97
B. Protect and Enhance Shorefront Environment		
1. Net Beach Acreage (Acres)	1.1	1.4
2. Impacted Structures (#)	1	0
3. Aesthetics (*)	2	2
4. Access	restricted along Reach G	no change
5. Fish and Wildlife	minimal impact	minimal impact
6. Other Environmental Impacts	none	none
7. Social Considerations	Improved Quality of Life due to reduction of flood threat	Improved Quality of Life due to reduction of flood threat

* Scale: 4 = highly desirable; 1 = not desirable

E. SELECTION OF RECOMMENDATION

Although Plan D has the greater net economic benefits due to the lower cost associated with earth dike versus seawall construction (along the Saugus River Reach), its adverse effects on the local environment and the number of structures physically impacted make selection of this plan difficult. With Plan E, the Point of Pines Yacht Club itself would not be impacted. Its beach area would not be part of the project's alignment and members would not have to traverse a dike to gain access to the shore and docks for launching and use of their boats.

In addition, considerable beach area east of the yacht club would be lost with construction of a dike measure versus a seawall. Access would be more difficult, with little gain in aesthetic quality. Both plans have the same design grade along the Saugus River reaches, so extent of view from the residential side is the same.

The adverse impacts associated with Plan D are too great to support its selection for recommendation. Plan E provides the same level of protection with less impacts by comparison. A Finding of No Significant Impacts (FONSI) for Plan E is included in the Environmental Assessment. In addition, because it reasonably maximizes net economic benefits consistent with protection of the environment, Plan E can be identified as the National Economic Development (NED) Plan.

Plan D is not consistent with protection of the environment because of its impacts along Reach G and is not acceptable to the public. Plan E is complete, effective, efficient and acceptable with regards to the water resource problems and opportunities in the Point of Pines study area. Plan E is selected for recommendation.

IV. SELECTED PLAN

A. OPTIMIZATION

Basically, the plan selected for recommendation (Plan E) utilizes three distinct different types of construction along the Point of Pines' shore. These include:

- Stone revetment, together with beach sand replenishment for Reaches A-D
- Sand dune development, with beach grass planting and fences for accretion, for Reach E
- A raised pre-cast concrete seawall along the same alignment as the existing seawall along Reaches F and G

Optimization of the selected plan was checked to insure maximization of net benefits. Design options of Plan E, providing protection against events having a 10, 1, and 0.2 percent chance of annual occurrence, were analyzed in an attempt to assure the optimum design. Table 8 summarizes pertinent data and illustrates that the Plan E option designed to provide protection against an event having a 1 percent chance of annual occurrence optimizes benefits versus cost.

TABLE 8
OPTIMIZATION
PLAN E

Item	Design Storm Event Chance of Annual Occurrence		
	10%	1%	0.2%
Average Annual Benefits ($1000)	1393	1565	1594
Average Annual Costs ($1000)	379	392	428
Benefit - Cost Ratio	3.7	4.0	3.7
Net Annual Benefits ($1000)	1015	1173	1166

B. STRUCTURAL FEATURES

No improvements or modifications will be made to existing interior storm drainage collectors as part of the proposed tidal flood control project. The existing pumping station, with a capacity of about 20 cfs is considered adequate for solely discharging interior rainfall runoff alone during high tides. As part of the planned tidal flood control project, emergency sluice gate closures will be provided where the discharge lines, to the Saugus River, pass through the line of protection.

A supplemental 36-inch diameter gravity drain will be provided extending from a new catchbasin on Rice Avenue through the line of protection just east of the existing pumping station. This new drain line will supplement the existing 36-inch drain to discharge any surface waters collecting in the interior in the event of an intense rainfall-runoff occurrence under normal tide conditions. Discharges will be conveyed from the line of protection to the Saugus River in the existing twin 36-inch diameter drains. The gravity drains would be equipped with flap gates, as well as emergency sluice gate closures, at the line of protection.

The twin drains would have a combined maximum capacity of about 100 cfs, or the equivalent to the peak one percent chance interior rainfall-runoff. The two outlets also serve to release interior waters in the rare event of appreciable post project tidal overtopping, once the storm tide receded.

The city of Revere has plans to rehabilitate the existing interior drainage system. This has been considered in the evaluation of alternative solutions. Proper operation and maintenance, along with any future improvements, are local responsibilities.

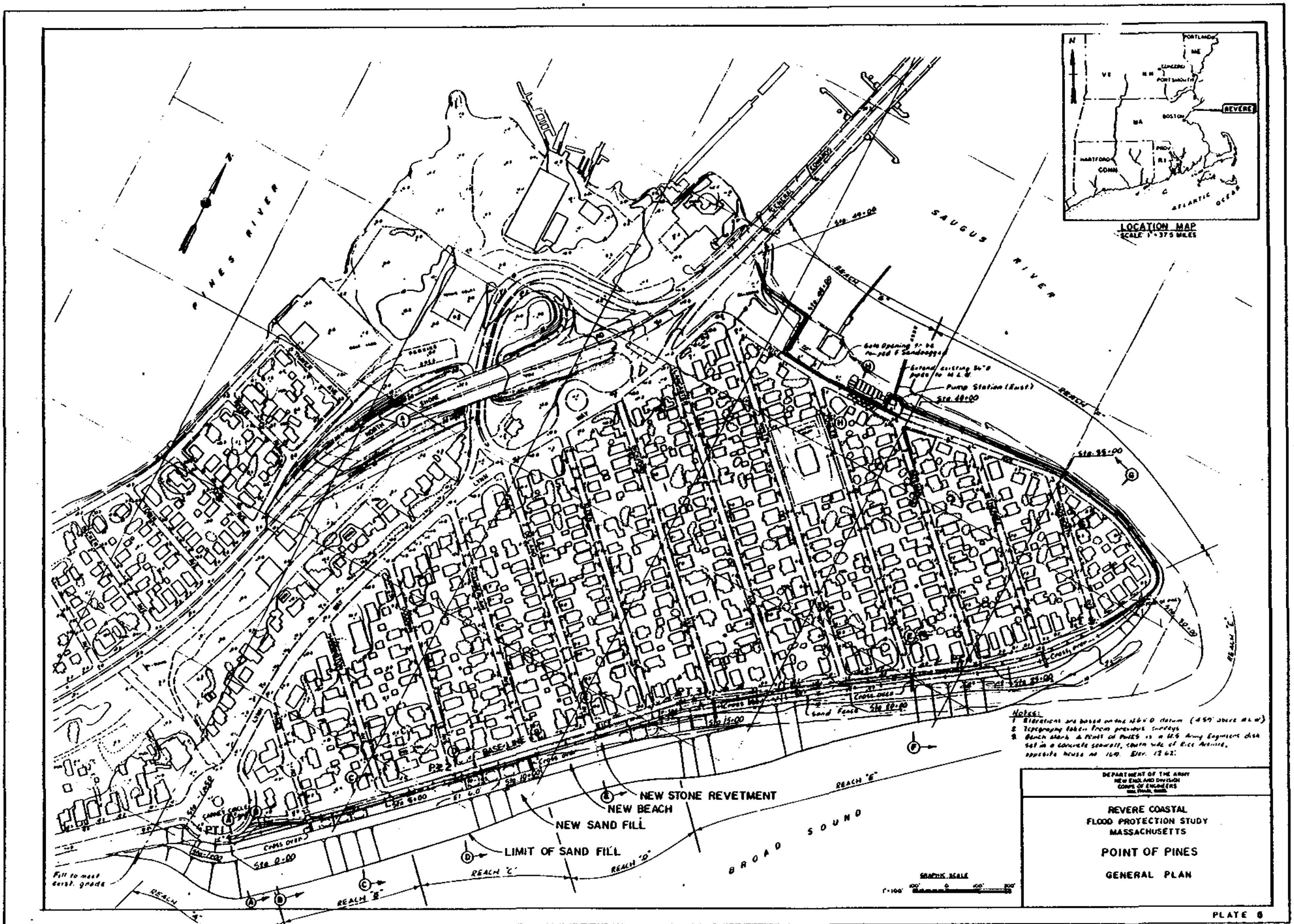
(1) Revetment

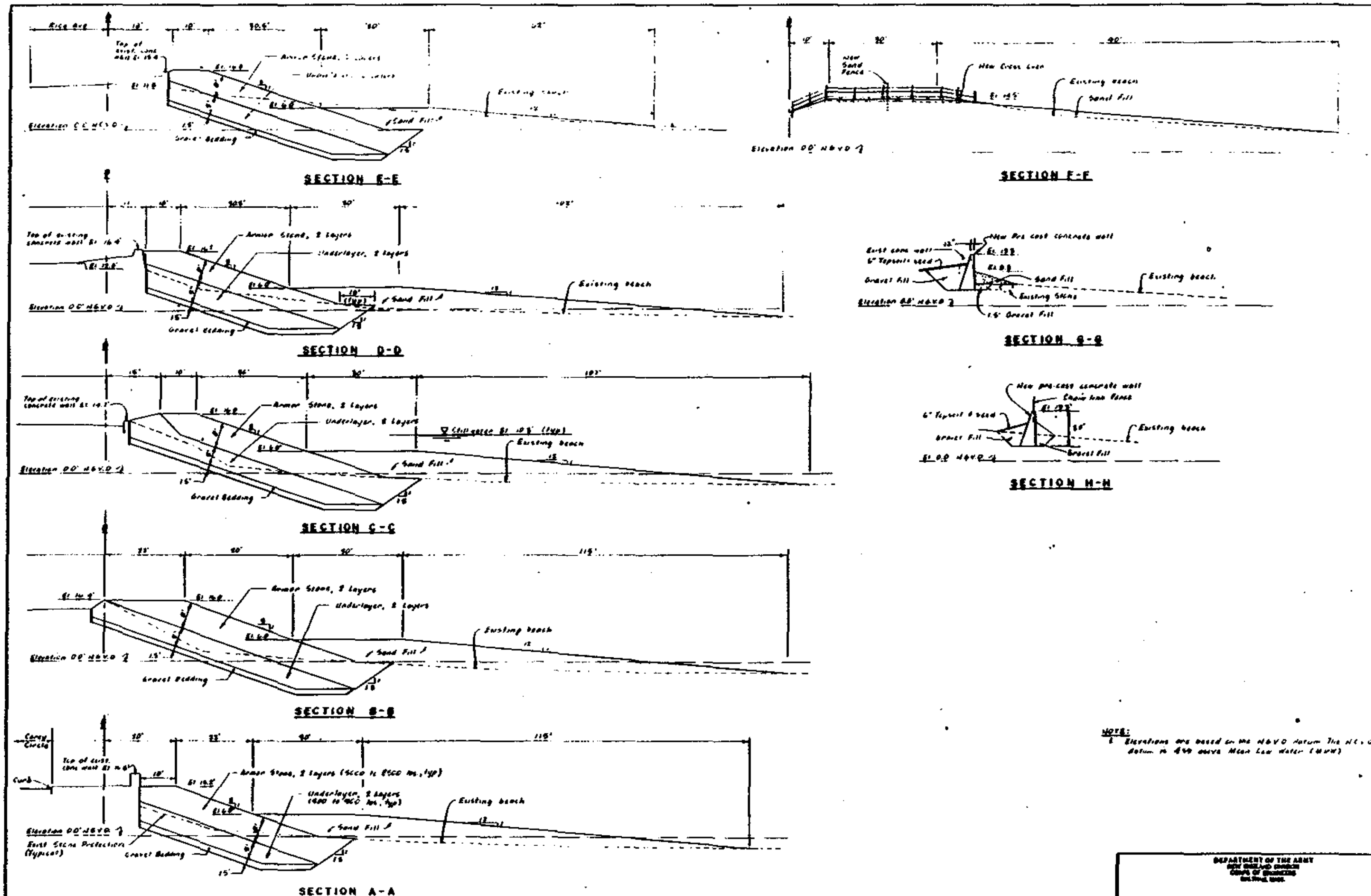
The existing top elevations in Reaches A, B, C, and D are 16.8, 14.1, 16.4, and 15.4 feet NGVD, respectively. The proposed revetment would start with a transition section in Reach A. The top elevation would gradually increase from 13.6 to 16.0 feet NGVD at station 0 + 00, as shown on Plate 5. This grade would remain the same up to station 10 + 00 (Chamberlain Avenue). There, the top elevation would start to decrease to 14.5 feet NGVD at station 14 + 00 (Alden Avenue). At station 14+00 is a transition section between the revetment and sand dunes.

The proposed revetment section would have a 8-foot thick layer of armor stone sloping 1 vertical to 3 horizontal down to the existing beach. The bottom of the slope would be keyed (toe) into the sand. A 5-foot thick underlayer of stone and an 18-inch thick layer of gravel bedding composed of quarry spalls (50 lbs to dust) would be placed under the armor stone.

In addition, about 30 thousand cubic yards of sand would be placed along Reaches A-D creating over one acre of new beach above mean high water (MHW). The sand fill would be distributed down to approximately the -2.6 foot NGVD contour. Along the 1,720-foot long Reach E, the beach currently in front of the existing sand dunes is about 50 feet wide at high tide. At low tide the beach is very flat and bathers have to walk a considerable distance to reach waist deep water. Because the natural littoral drift is from south to north, any sand placed in Reaches A-D is expected to move to Reach E- should any drift take place during the project's life. This fact, in addition to the natural barrier beach at the Nahant Causeway (Lynn Beach), indicates that any beach fill placed would be relatively stable and require minimal maintenance.

Beach access would be provided by walkways over the protection to the beach area. Since there is no access currently provided through Reaches A and B, the first walkway would be located at the beginning of Reach C at Harrington Avenue (station 5 + 00). Similar access would also be placed at the ends of Goodwin, Chamberlain and Delano Avenues (stations 7 + 50, 10 + 00, and 12 + 00, respectively).


LOCATION MAP
REVERE
ATLANTIC OCEAN
PINES RIVER
SAUGUS RIVER
BROAD SOUND
NEW STONE REVETMENT
NEW BEACH
NEW SAND FILL
LIMIT OF SAND FILL
REACH "A"
REACH "B"
REACH "C"
REACH "D"
REACH "E"
Pump Station (East)
Notes:
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
REVERE COASTAL
FLOOD PROTECTION STUDY
MASSACHUSETTS
POINT OF PINES
GENERAL PLAN
PLATE 6



TYPICAL SECTIONS

SCALE: 1" = 10' HOR
1" = 10' VER

DEPARTMENT OF THE ARMY

REVERE COASTAL
FLOOD PROTECTION STUDY
MASSACHUSETTS

POINT OF PINES

TYPICAL SECTIONS

GRAPHIC SCALE

PLATE 6

(2) Sand Dunes

The top elevation along the existing sand dunes varies from 12.1 to 16.6 feet NGVD. The low points are generally confined to the areas at the ends of several streets. Pedestrian traffic to the beach has "worn down" the dunes. During the February 1978 Blizzard it was reported that overtopping of the dunes occurred in these low areas.

The proposed plan of protection for Reach E would include raising the existing dunes to a continuous elevation of 14.3 feet NGVD and selective planting of beach grass to stabilize the area. It is estimated that 6,700 cubic yards of sandfill would be required. In addition, a "sand" fence would extend along the dune crest to assure the development of the system and minimize foot traffic over the protection.

In order to allow for access to the beach, wooden ramps would be constructed over the dunes. These would be located at the ends of Bickford, Lancaster, Whitin, Fowler, Bateman, Witherbee, and Wadsworth Avenues (stations 15 + 70, 18 + 00, 20 + 00, 22 + 00, 24 + 00, 26 + 00, and 28 + 00, respectively).

(3) Seawall

In Reaches F and G, the proposed protection would be a raised, pre-cast concrete seawall at top elevation 13.3 feet NGVD. This seawall would run along the alignment of the existing protective structures and property lines on the northern edge of Rice Avenue along the Saugus River. Because high wave energy dissipation is not required here, the top of this wall was set only 3 feet above the stillwater tide level of the Blizzard of 1978 (an event having a 1 percent chance of occurrence annually).

Like the other reaches, access to the beach would be provided with similar walkways over the protection at the ends of Wadsworth and Witherbee Avenues (stations 35 + 50 and 38 + 00, respectively). The 20 foot wide entrance to the Point of Pines Yacht Club would be sandbagged during flood events.

Finally, a last walkway would be located at station 47 + 00 to provide access to the beach where the plan's alignment would run along private land to existing high ground at North Shore Road. In addition, about 50 cy of gravel toe protection would be placed on the riverside from station 46 + 50 to 49 + 00 to prevent possible scour due to currents and eliminate any "blind spots" from the view of the adjacent homes.

V. IMPLEMENTATION

A. ECONOMICS

(1) Estimate of Costs

TABLE 9
ESTIMATE OF COSTS
PLAN E
(OCTOBER 1984 PRICE LEVELS)

Description	Quantity	Unit	Unit Price	Amount
Site Prep	1	Job	LS	$10,000
Mob/Demob	1	Job	LS	25,000
Excavation	37,900	CY	$20.00	758,000
Gravel Bedding	8,950	CY	10.00	89,500
Underlayer Stone	16,000	CY	25.00	400,000
Armor Stone	29,300	CY	30.00	879,000
Sandfill (void fill)	8,800	CY	8.00	70,400
Sandfill (beach fill)	21,250	CY	8.00	170,000
Dune Sand	6,700	CY	8.00	53,600
Beach Grass	13,200	EA	1.00	13,200
Sand Fence	1,700	LF	3.00	5,100
Beach Access	14	EA	7000.00	98,000
Topsoil, Seeded	1,900	SY	1.50	2,850
Precast Conc. Wall	760	LF	85.00	64,600
Precast Conc. Wall	960	LF	90.00	86,400
6' Chain Link Fence	500	LF	14.00	7,000
Pump Station	1	Job	LS	150,000
Sandbags	280	EA	5.00	1,400
	Subtotal			$2,884,050
	Contingencies			715,950
TOTAL ESTIMATED CONSTRUCTION COST				$3,600,000
Engineering and Design				$375,000
Supervision and Administration				225,000
Real Estate				160,000
TOTAL FIRST COST				$4,360,000
Interest During Construction				294,000
TOTAL INVESTMENT				$4,654,000
Interest and Amortization (8-3/8%, 100 years)				389,900
Average Annual Operation and Maintenance				2,500
TOTAL ANNUAL COSTS				$392,400

(2) Benefits

Flood control benefits from implementation of protective measures are derived from losses prevented. These benefits include reduction of flood inundation, accrual of affluence values, emergency expenses, and insurance administration offset and other intangibles.

Flood inundation costs are separated into two types - physical and nonphysical. Physical losses include the expected damage to structures and their contents. Nonphysical losses take into account such items as loss of work and costs of temporary housing and food.

Affluence benefits are based on the concept that the real value value of residential contents will increase as real per capita income increases. As contents' values grow, the potential dollar amount of damages to those contents grows.

Emergency costs are defined as expenditures which result from emergency activities prior to, during, and after a flood. Emergency costs include expenses for flood emergency centers, communication facilities not otherwise needed, temporary evacuation assistance, flood fighting materials and personnel, additional police and fire protection, and public clean-up.

In addition to those previously described, intangible benefits would accrue if the project is implemented. These benefits include a reduction in health hazards and an improvement in the social and economic wellbeing of residents and economic activities in the area. The threat of flooding would be greatly reduced.

Table 10 shows a summary of estimated annual benefits from implementation of the recommended plan. Those attributable to affluence reflect the current interest rate of 8-3/8 percent.

TABLE 10
ESTIMATED ANNUAL BENEFITS
PLAN E
(OCTOBER 1984 PRICE LEVELS)

Flood Inundation Reduction	$1,308,000
Affluence	130,000
Emergency	108,000
Insurance Administration	19,000
TOTAL	$1,565,000

(3) Feasibility

The Benefit-to-Cost Ratio (BCR) is an indicator of economic feasibility. When the benefits outweigh the costs of implementation; that is, the BCR is greater than unity, the project is economically justified. The recommended plan has estimated annual benefits of $1.6 million, and estimated annual costs of $392 thousand. The BCR is 4.0 to 1. The project reasonably maximizes net economic annual benefits at $1.2 million.

Plan D, another final array alternative, called for a less expensive design along one reach, but resulted in too great an impact upon residents and the local environment. Both plans offered the same level of protection.

The economic difference between the two plans is not considered significant enough to compensate for the expected environmental impacts of the cheaper plan. Plan E, the selected plan, is consistent with protection of the environment. Plan D accounts for only a 5.6 percent increase in net economic benefits. Plan E's BCR of 4.0 compares favorably to the 4.8 BCR of Plan D.

B. CONSTRUCTION

(1) Procedures

To construct the project, easements would be required on the landside of the existing facilities. The working zone would need traffic control typical of projects of this nature. Construction would be only during the off-seasons of fall and spring. In addition, work would only occur during periods of low tide. It is estimated that the project would take a maximum of two years to complete. Impacts are discussed in more detail in the Environmental Assessment.

Renourishment of Revere Beach, an authorized Corps project to the south of Point of Pines, is currently being studied by the New England Division. Plans and specifications for Point of Pines would be coordinated with this effort so that both designs, especially at the transition zone near Carey Circle, are compatible.

(2) Materials

Construction materials would be gravel for fill, rock for slope protection and sand for beach fill and sand dune construction. Gravel can be obtained from commercial suppliers within a 30-mile radius of the study area. Rock and sand can be obtained from commercial suppliers within a 40-mile radius of the study area.

(3) Facilities

Construction of the project would require a moderate size work force with varied construction skills, largely in the heavy equipment and semiskilled trades. Within the greater Boston area, there is a sufficient number of workers who could commute to work and not require housing near the project.

There would be a need for administration, mobilization and storage at the project site. In the area there are a number of possible sites suitable for such staging requirements. Specific locations will be identified during later, more detailed studies. Temporary facilities required by the Contractor and the Government would be removed at the conclusion of work and the site(s) restored, or finished, as required.

C. OPERATION AND MAINTENANCE

(1) Transition

Upon completion of construction, the project is turned over to the local sponsor(s) as their responsibility. The project is designed to be complete within itself and does not obligate the Federal Government to any future work.

As part of the transition phase following construction, an Operation and Maintenance (O&M) Manual will be prepared by the New England Division and forwarded to the responsible parties. This manual will reflect the project features, as actually built, and provide direction regarding their proper O&M.

It should be recognized here that estimated O&M costs, included herein, are provided for economic analyses only and are not included in project first costs or apportionment. The local sponsor(s) should be aware that their responsibility includes future funding of all O&M items and should be budgeted accordingly.

Finally, the completed project will be inspected semi-annually by personnel from the New England Division, together with the responsible parties, to insure compliance with the intended purpose.

(2) Operation

The selected plan for coastal flood protection of Point of Pines does not include any mechanical measures. However, the operation of the existing pump station and interior drainage collection system is an important component in keeping interior flood levels at an acceptable level. Although not part of the Federal project, it is urged that this system be kept operational at all times.

The entrance to the yacht club will require sandbagging in extremely rare storm events. The actual tide level at which sandbagging is to be initiated will be identified in the O&M Manual. If not accomplished, the project will not provide the intended level of protection. The local sponsor(s) will be responsible for this effort as part of their requirements of local cooperation.

(3) Maintenance

The rock revetment measures of the recommended plan do not call for any unusual maintenance efforts. The local sponsor(s) would be required to control any vegetation that may threaten the structure's integrity. Any rock that may be displaced, by whatever cause, would be replaced by the local sponsor(s).

The sand dune system and protective beach grass vegetation would require continued attention to insure its effectiveness. The "sand" fences and walkways should be kept intact to prevent needless erosion of the dunes. Dune vegetation should be maintained to remain effective. Any sand displaced or moved by severe storm events would have to be mechanically redistributed or bulldozed back. The sand included in the recommended plan is a one-time placement. Renourishment is not a part of the protective measures.

The pre-cast seawall sections are designed to require a minimal maintenance effort. Grouting would have to be periodically done between the pre-cast sections to prevent seepage and instability. Other maintenance associated with concrete work, such as prevention of spalling, can also be expected.

D. INSTITUTIONAL REQUIREMENTS

(1) Cost Allocation

All measures considered are single purpose flood control. Thus, all costs are allocated to flood control.

(2) Cost Apportionment

Section 205 of the 1948 Flood Control Act, as amended, outlines cost sharing and local cooperation requirements with regards to small local protection projects. This report presents information based upon application of these traditional requirements. The Administration is reviewing project cost sharing and financing across the entire spectrum of water resource development functions. The basic principle governing the development of specific cost-sharing policies is that whenever possible the cost of services produced by water projects should be paid for by their direct beneficiaries. It is recognized that the Federal Government can no longer bear the major portion of the financing of water projects. New sources of project financing, both public and private, have to be found.

While specific policies applicable to the Point of Pines project have not yet been established, non-Federal interests can expect that, under the Administration's financing and cost sharing principles, the level of their financial participation will need to be greater than in the past.

The Federal share for local protection projects constructed under the Small Projects Program is limited to a maximum of $4 million. This limit is exclusive of the necessary real estate requirements which, together with operation and maintenance, are a non-Federal responsibility. Table 11 illustrates the cost apportionment for Plan E, the recommended plan.

TABLE 11
COST APPORTIONMENT
PLAN E
(October 1984 Price Level)

Item	Federal	Non-Federal
Project First Cost	$4,000,00 1/	$650,000 2/
Annual Operation & Maintenance	-	2,500

1/ includes pre-authorization costs of $290,000
2/ includes real estate requirements

E. RESPONSIBILITIES

(1) Federal

The Federal Government would design and prepare detailed plans, construct the project, and share in the cost of the proposed project as set forth above. Construction would be contingent on funding and the receipt of the non-Federal share of the total project cost.

(2) Non-Federal

Formal assurances of local cooperation must be furnished by the city of Revere. The local sponsor must agree to:

• Provide without cost to the United States all lands, easements, and rights-of-way necessary for construction of the project.

• Hold and save the United States free from damages due to construction, operation, and maintenance of the project, not including damages due to the fault or negligence of the United States or its contractors;

• Maintain and operate the project, including the interior drainage facilities, after completion of construction in accordance with regulations prescribed by the Secretary of the Army;

• Accomplish without cost to the United States all alterations and relocations of buildings, streets, storm drains, utilities, highway bridges, and other structures made necessary by construction of the project;

• Provide a cash contribution, in-kind services, or a combination of both for project costs in excess of the $4 million Federal limitation, less the value of all lands, easements, rights-of-way and relocations necessary for construction;

• Provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms.

F. PROCEDURE

Following the review and approval of this document by the Office of the Chief of Engineers and the allocation of funds, plans and specifications for construction of the measures included in Plan E would be prepared by the New England Division. At that time a formal document would be required from the city of Revere reaffirming their intent to support the selected plan and fulfill the requirements of local cooperation.

Following the receipt of this formal document, bids for construction of Plan E would be invited by the Corps for the award of a contract. With timely project approval and funding, it is estimated that this work could be performed by the end of 1987. Upon completion, local interests would be responsible for all operation and maintenance of the project.

VI RECOMMENDATIONS

I have considered all significant aspects in the overall public interest including environmental, social, and economic effects and engineering feasibility in concluding that the selected plan of protection described herein is the best implementable alternative meeting the objectives of this investigation.

I recommend that a system of rock revetments, sand dune development, beach nourishment and a concrete seawall, identified as Plan E, selected herein to provide coastal flood protection, be authorized for implementation as a Federal project, with such modifications as in the discretion of the Chief of Engineers as may be advisable, at a total first cost presently estimated at $4,360,000.

The non-Federal sponsors for this project would be the city of Revere in cooperation with the Commonwealth of Massachusetts. The non-Federal share of total project first cost is presently estimated at $360,000 and they are responsible for the items of local cooperation listed herein, including average annual operation and maintenance costs currently estimated at $2,500.

I recommend that funding in the amount of $440,000 be provided to prepare plans and specifications. These recommendations reflect the information available at this time and current departmental policies governing the formulation of individual projects. It is recognized that they do not reflect program and budgeting priorities inherent in the formulation of a national Civil Work's construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are approved for authorization and/or implementation funding by the Chief of Engineers.

DATE

CARL B. SCIPLE
Colonel, Corps of Engineers
Division Engineer

VII ENVIRONMENTAL ASSESSMENT

ENVIRONMENTAL ASSESSMENT
404(b) EVAULATION
FINDING OF NO SIGNIFICANT IMPACT

FOR THE
POINT OF PINES
COASTAL FLOOD PROTECTION STUDY
REVERE, MASSACHUSETTS

Prepared by
Gib Chase
Environmental Resources Specialist

JULY 1984

DEPARTMENT OF THE ARMY
NEW ENGLAND, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

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POINT OF PINES, REVERE, MASSACHUSETTS
COASTAL FLOOD PROTECTION STUDY

I. PURPOSE AND NEED FOR ACTION

The coastal flood protection study for the Point of Pines area of Revere, Massachusetts has evaluated numerous plans for providing reduction or prevention of recurring flood damages. Point of Pines is located at the extreme northern end of the 3-mile-long Revere Beach, a popular public recreation facility owned and maintained by the Metropolitan District Commission (MDC). Revere is located 5 miles north of downtown Boston, on the Massachusetts coast (Fig. EA-1). Point of Pines is a heavily settled residential area consisting of over 360 dwellings. Flooding is particularly severe when southeast storm or hurricane winds combine with ocean high tides to produce wave overtopping of existing seawalls and subsequent flooding of inland areas. Recent severe flooding occurred in December 1959, February 1972, and most recently in February 1978, during the "Blizzard of "78." The storm of February 1978 was the worst flood experienced. About 50 percent of the residents indicated that they had to be evacuated! The entire area lies within the flood plain, extending to the Lynnway. The major flooding occurs at high tide when storm driven waves overtop the existing protection.

Additional detail information on coastal flood protection for the Revere Beach area can be obtained from the Water Resources Investigation Interim Report and Environmental Assessment/404(b) Evaluation prepared by the New England Division Army Corps of Engineers for Roughans Point issued December 1982 and revised October 1983, and the MDC's environmental report prepared by Camp, Dresser and Mckee Inc., 1978. Roughans Point is located at the southern end of Revere Beach.

Project Study Authorization

This project study is authorized by Section 205 of the 1948 Flood Control Act as amended (See page I-1, Section I of the Main Report).

Study Area

The Point of Pines study area begins at Carey Circle and runs northeasterly and westerly along the entire length of Rice Avenue to the General Edwards Bridge. For the purpose of our investigation the overall area was broken down into study reaches according to various existing shorefront features as shown on the attached plan. They are:

REACH	LENGTH	SHOREFRONT FEATURE
A	230'	Carey Circle
B	440'	Revetment
C	430'	Precast Concrete Wall and Revetment
D	430'	Poured Concrete Wall
E	1720'	Sand Dunes
F	970'	Precast Wall
G	730'	Beach & Yacht Club

Proposed Plan of Action

The attached plans and cross sections indicate the proposed flood protection plan for Point of Pines. In our formulation we have tried to minimize adverse impacts on the visual aesthetics and environmental surrounding while still providing a high degree of flood protection. The top elevation of the revetment section is set at 16.0 feet NGVD and prevents 97 percent of the annual flood damages. The plan will not be disruptive to the dune area.

The recommended plan would utilize three distinctly different types of construction in the seven reaches of Point of Pines. These include:

(1) Stone revetment and beach sand replenishment along Reaches A to D. This portion of the project study area includes Carey Circle to Alden Avenue. Approximately 30,000 cubic yards of sand will be trucked in from a landbased source site for placement over the toe of the revetment structures. The proposed revetment would start with a transition section in Reach A having a top elevation gradually increasing to 16.0 ft. NGVD, with a 1:3 slope down to the existing beach. The grade would be gradually reduced from Chamberlain to Alden Avenues to 14.5 ft. NGVD (430 Linear feet) where it meets with Reach E. The sandfill will be distributed down to the -2.6 ft NGVD contour. Mean low water is at elevation -4.6 ft. NGVD. Although no flood protection benefits are taken for this proposed sand fill, if maintained, it would undoubtedly lower the wave runup. Commercial sand sources appear to be available but have not been specified

(2) Sand dunes are an important protective formation. The dune ridges along Reach E will be replenished to buffer the movement of storm tides and waves into the area behind. Use of vegetation is desirable to stabilize dune sand that might migrate. At some locations subject to inundation by storms, a belt of dunes can provide protection more effectively at a lower cost than a seawall. The plan will raise the dunes to elevation 14.3 ft. NGVD from Alden Avenue to the mouth of the Saugus River. Here 6,700 cy of sand will be added.

(3) Seawall along Reaches F and G. The recommended plan proposes to provide a concrete wall with a top elevation at 13.3 ft. NGVD. The new

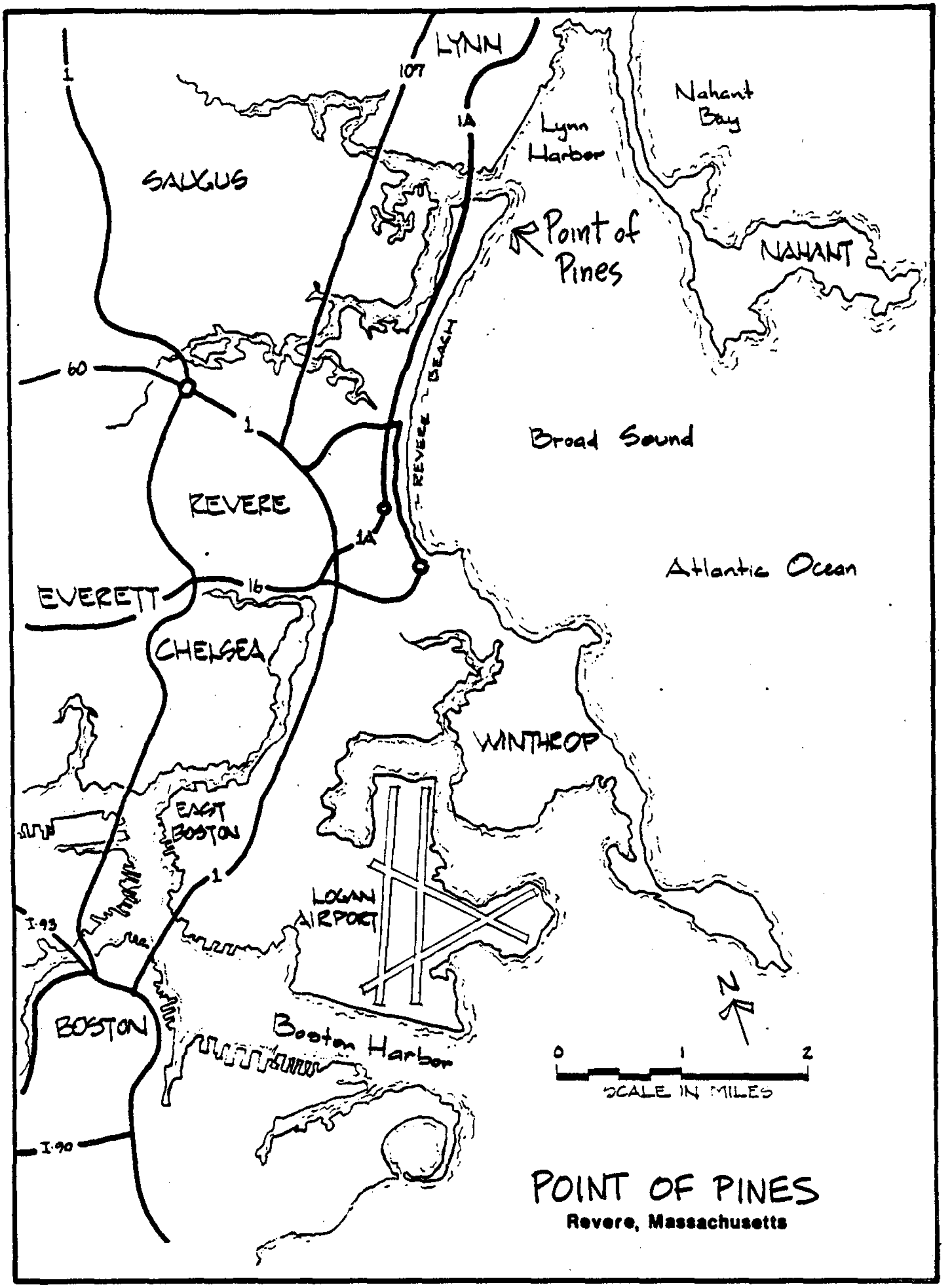

LYNN
107
1A
1
Nahant
Bay
Lynn
Harbor
SAUGUS
Point of
Pines
NAHANT
60
1
REVERE BEACH
Broad Sound
REVERE
1A
Atlantic Ocean
EVERETT
16
CHELSEA
WINTHROP
EAST
BOSTON
1
LOGAN
AIRPORT
I-93
N
BOSTON
Boston Harbor
0
1
2
SCALE IN MILES
I-90
POINT OF PINES
Revere, Massachusetts

Figure EA-1

wall would only be about 8 inches higher than the existing wall. Like the other reaches, access to the beach would be provided by walkways over the protection where access currently exists. The entrance to the yacht club would be sandbagged during flood conditions.

The recommended plan will prevent 97% of the average annual damages and is designed to withstand the 100 year storm event. Approximately 29,000 cubic yards of armor stone, 16,000 cubic yards of underlayer stone and 9,000 cubic yards of bedding stone will be required for the revetment walls. It is estimated that the construction time to complete the project will require two years.

II. ALTERNATIVES CONSIDERED

In the early stages of plan formulation, a number of alternatives were investigated but eliminated from consideration due to their prohibitive costs or environmental impacts (a more detailed discussion is presented in the main report). These include, but are not limited to: breakwater(s), total beach replenishment, a number of wall alternatives, and non-structural measures such as floodproofing. A brief overview of some of these alternatives and the associated environmental impacts comprise this section.

No Action - The "no action" or without condition is based on the most probable future condition, assuming no new Federal participation in water resources projects in the Point of Pines area. Under this situation, no implementation of methods to alleviate or reduce the flood problems would be expected. Both the monetary investment and potential adverse impacts associated with structural improvements would be avoided. However, this would subject Point of Pines to continued flooding which threatens both man's environment and a portion of the terrestrial, coastal ecology as it exists today. Man's well being is significantly affected by storms whose destruction is made more evident by denuded beaches, destroyed homes and businesses, and threatened lives. With continued flooding, property values would decline, the beach biome degrade, and the area suffer the associated economic and physical losses.

Non-Structural Alternatives

A general survey conducted by the Corps of Engineers showed nonstructural measures such as floodproofing, building code and zoning regulations and public acquisition of flood hazard lands; to receive relatively low preference from residents, except for two: (1) expanding flood insurance coverage and (2) developing a community-wide warning and evacuation plan. Survey results indicated general preference for measures which would actually provide flood damage reduction, but result in the least disruption to individual personal properties. These non-structural measures would appear to represent the least environmental disturbance; however, they make were eliminated because the type of severe flooding experienced by Point of Pine tradtional non-structural measures inappropriate. If non-structural measures are implemented without shoreline protection, the area will still be subject to deep flooding and possible loss of life.

Structural Alternatives

Shoreline Revetment. The construction of onshore structures is the most direct method of protecting a shoreline from continued flooding or erosion. Although there are many types of revetments and many kinds of material available for their construction, a rock riprap type as proposed, would be the most practical and feasible type for reaches A-D of the Point of Pines shoreline based on existing conditions, cost, ease of construction, availabilty of materials, durability, and maintenance. Concrete walls alone are not feasible at Point of Pines due to their excessive costs. Also, their required massive heights would have severe impacts on study area aesthetics. The rock revetments have been kept to the minimum width feasible, but must be constructed seaward of existing seawalls due to physical constraints.

The major disadvantages of a revetment is its man-made appearance and potential impacts it might have on the beach due to the possible modifications in longshore sediment transport (US Fish and Wildlife Service, 1980). The 1,570 foot long structure proposed for Reaches A to D, would permanently protect the backshore area from flooding and erosion and would be aesthetically compatible with the existing poured and precast concrete walls and revetments characterizing the area. A sand beach would be constructed in conjunction with the revetment plan.

The proposed plan of protection for Reach E would include raising the low points of existing dunes to elevation 14.3 ft NGVD and selective planting of beach grass to stabilize the area. It is estimated that 6,700 cubic yards of sandfill would be required. In order to allow for access to the beach wooden ramps would be constructed over the dunes. These would be located at the ends of existing streets. A rolled, portable "sand" fence would extend along the dune crest between the access ramps in order to minimize foot traffic over the top of the dunes and prevent possible erosion.

Dune planting with appropriate grasses reduces windborne losses landward and aids in dune preservation. It is recommended that the American Beach Grass (Ammophilia brevigulata) be mixed with 10% (Panicum Amarum). It is also recommended that a variety of beach grass adaptive to low sand movement be used, which is better suited for stabilization.

Seawalls. Protection of shore development can be accomplished by constructing wave-resistant walls of various types. Seawalls may have vertical, curved or stepped faces. While seawalls may protect development, they can also create a problem. The downward forces created by waves striking the wall can rapidly remove sand from in front of the wall. A stone apron is often necessary to prevent this excessive scouring and undermining. A seawall constructed on piles with sheet pile cutoff walls would be effective in minimizing tidal flood damage to development behind the wall. However, without widening and raising the beach berm in front of the wall, wave action would accelerate the loss of beach material. Therefore, any plan which considers seawall construction must include measures to protect the beach. Beach berm construction and nourishment, along with a seawall, can be an effective tidal flood protection measure.

A pre-cast concrete seawall, with top elevation 13.3 ft NGVD, is proposed for Reaches F and G. It would run along the alignment of the existing protective structures along the Saugus River. In this manner, preservation of the existing condition is accomplished as much as practical while still providing the flood protection needed.

The Proposed Plan - Generally, the selected plan of protection utilizes existing protection to best advantage and adds structural improvements to increase their effectiveness for flood control. Rebuilding and renourishment of the dunes area at Point of Pines effectively provides the design flood protection with additional benefit of environmental preservation, compatible with community desires.

The proposed improvements are economically feasible, cause the least disruption to private properties and minimum loss of recreational beach area, and is the plan of protection which reasonably maximizes net economic benefits. The proposed plans as described in Section I, will have no significant impacts upon fish and wildlife resources (See F&WS Planning Aid letter). However there would be minor losses, from disturbance during construction, of the shore and beach habitat covered by the measures. Public access to the beaches would be maintained wherever it is currently available, and measures to confine people to walkways will be provided to prevent dune erosion and protect vegetation.

III. AFFECTED ENVIRONMENT

Project Area Description

Lynn Harbor is an approximately triangular basin, opening to the south into Broad Sound and Massachusetts Bay. The average depth of the harbor is only 5.1 ft. The harbor is bounded on the east by two rocky headlands, Nahant and Little Nahant, connected by tombolos to form a 3.2-mile long complex bounded on the west by the Lynn waterfront, the Saugus and Pines River Inlet, and Revere Beach (Figure EA-1). Point of Pines, a peninsula at the mouth of the Saugus River, is a deposit of river sands and marks the northern most end of Revere Beach. The project study area extends from the Carey Circle rotary in the south to the mouth of the Saugus River near the General Edwards Bridge. Point of Pines is a densely developed residential neighborhood.

Fisheries

The Revere Beach area, from Roughans Point to Lynn, and the Saugus and Pines River have historically been popular fishing areas. Indians once fished here for abundant salmon, trout, alewives and bass. Early colonists established commercial fishing for bass, herring, and cod. By the nineteenth century, commercial fishing in the area expanded to include haddock, mackerel, cunner and eels. The area still supports popular sport fishing.

Shorezone fish of Lynn Harbor are typical of northeast estuaries; dominant species are Atlantic silversides (Mendia menidia), mummichogs, (Fundulus heteroclitus and F. majalis), sticklebacks (Apeltes quadracus), and occasional tomcod (Microqadus tomcod) (Chesmore et al., 1972; Raytheon, 1971, 1972a, 1973). Near shore fishes were more abundant in the Saugus and Pines River areas than in the harbor proper during these studies.

Winter flounder Pseudopleuronectes americanus were abundant in trawls taken in the Pines and Saugus Rivers and near Point of Pines, and were the dominant finfish species. Other species characteristic of the harbor were yellowtail (Limanda ferruginea), tomcod (Mieroquous tomcos), ocean pout (Macrozoarces americanus) longhorm sculpin (Myoxocephalus octodecimspinosus), white hake (Urophycis tenuis) and little skate (Raia erinacea) (Chesmore et al., 1972; Raytheon, 1971, 1972a, 1973).

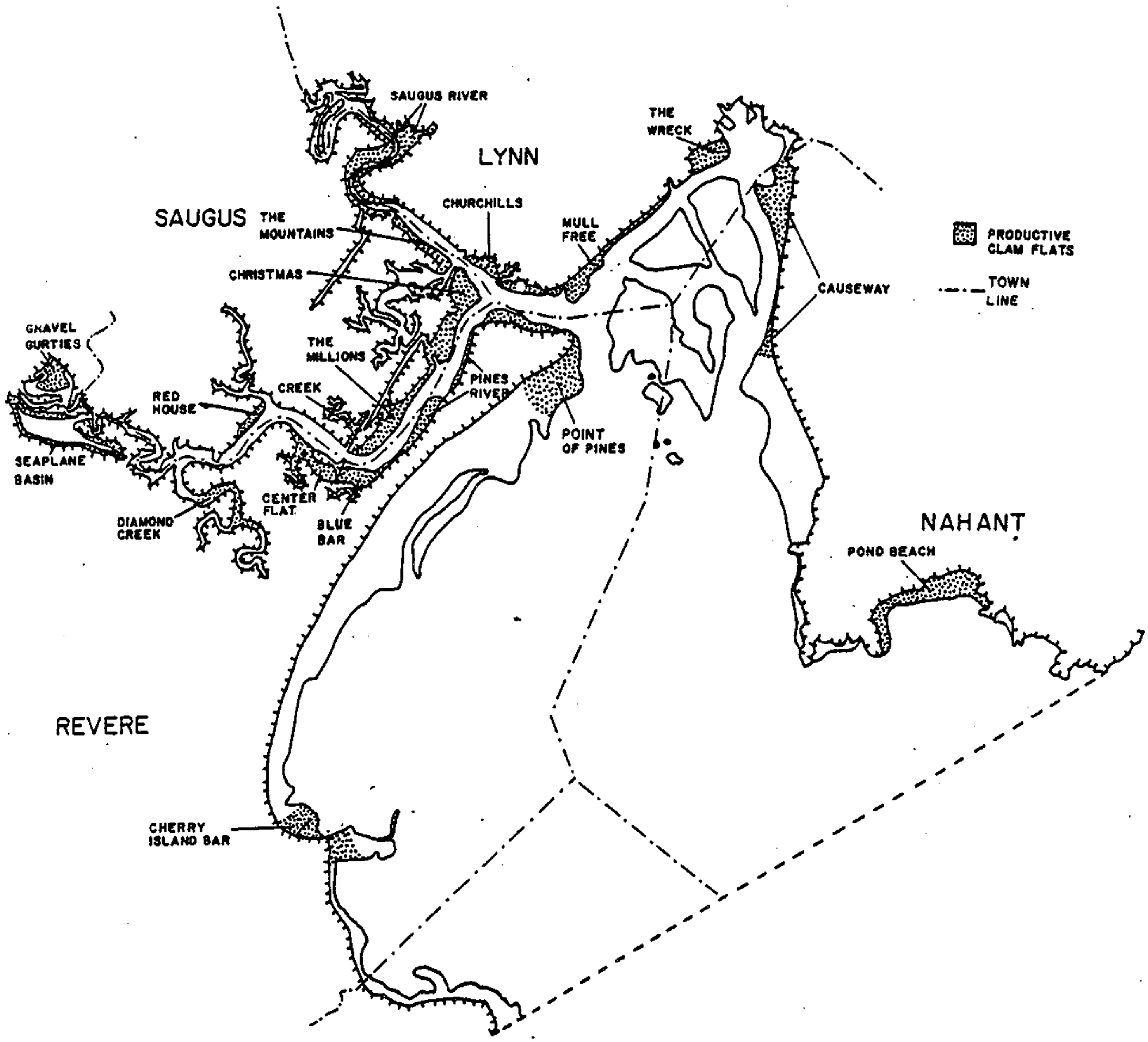
Data indicate that the Pines and Saugus Rivers are important winter flounder (Pseudopleuronectes americanus), nursery areas, and that they support modest rainbow smelt (Osmerus mordax), and shad Alosa sapioissima. Lynn Harbor supports a recreational fishery for adult winter flounder (Pseudopleuronectes americanus), year-round, and a seasonal fishery for cod (Gadus cauarias, mackerel (Scomber scombrus), pollock (Pollachius virens), and bluefish (Pomatomus saltatrix).

Shellfish

The Lynn-Saugus Harbor area, including Revere, the Saugus and Pines Rivers, and Nahant, contains approximately 440 acres of productive soft shell (Mya arenasia), clam habitat, or clam flats (see Figure EA-2). This area was the primary source for soft shell clams in the early twentieth century, but increasing pollution resulted in harvest restrictions in most of the area by 1926. Only the waters and tidal flats of the Pines River, including Diamond Creek, lying northwesterly of Route 107, remain open to shellfish harvest.

Benthic Ecology

Chesmore et al., (1972) noted the presence of other taxa in their 1969 Mya arenaeu survey and resurveyed the "Mull Free" flat in 1978. Raytheon (1971, 1972, 1973) collected benthic grab samples at the power



Location of the productive soft shell clam habitat in Lynn-Saugus Harbor, 1968-1969.

Source: Chesmore, A.P., D.J. Brown and R.D. Anderson. A Study of the Marine Resources Of Lynn-Saugus Harbor. Massachusetts Dept. of Natural Resources, Div. of Marine Fisheries, Monograph Series No. 11. 1972

FIGURE EA-2

plant site at Lynn Harbor, the Saugus River mouth, and the Lynn sewer discharge site on the central harbor mussell shoals, and maintained successional panels at two of the sites. Benthic invertebrates were also enumerated in Raytheon's bottom trawls (Normandeau Associates, 1980). A project-specific study was initiated by the US Army Corps of Engineers in 1980, as part of a now inactive Lynn Harbor navigation improvement study, and is described below under the paragraph entitled "Subtidal Fauna."

(a) Clam Flats

"Productive clam (Mya arenaria) flats occurred over 439.9 acres of intertidal area in Lynn Harbor with a 1971 mean standing crop of 96.2 bushels per acre of intermediate and "legal" (length 51 mm) clams. Flats within the project area comprised 33.4 percent of the standing crop and 32.5 percent of the productive acreage. The Wreck and Mull Free flats were relatively high in density, the Churchill and Causeway flats were about average and Point of Pines flat ranked 20th among 22 stations in clam density. A 1978 resurvey of the Mull Free flat indicated that the standing crop had not changed significantly although the size/age frequency distribution was very different in 1978 from the kind of distribution evident of 1971.

It is possible that the central mussel shoals were once productive clam flats which evolved into their present "climax community" through a successional procession.

(b) Intertidal Fauna

Chesmore et al. (1972) found blue mussels (Mytilus edulis), duck clams (Macoma balthica), clam worms Nereis sp.) and tellin shells (Tellina agilis) on the clam flats they sampled. Raytheon's study was characterized by Mytilus edulis, Littorina littorea and Mya arenaria (Raytheon, 1973). VTN Consolidated, Inc. cites Raytheon (1972), stating that the green crab (Carcinus maenas) was also abundant in the Lynn Harbor intertidal zone." (Normandeau, 1980)

(c) Subtidal Fauna

A project-specific survey of benthic fauna was made by Jason M. Cortell and Associates, Inc. and Taxon, Inc. on June 12, 1980 in conjunction with a now inactive Corps navigation improvement study. Of the eight stations sampled two were located in the general vicinity of Point of Pines. These are described as follows:

Station 3 is in shallow water northeast of the mouth of the Saugus River. The sediment is muddy sand. This station had the lowest diversity of all locations examined. The community was dominated by polychaetes Capitella sp. Polydora ligni, which comprise 88 percent of the community.

Station 4 lies south of Station 3 and due east of the Point of Pines. The coarse sand and gravel are indicative of fast moving water. The diversity was high and this station had more species than any of the other stations. The fauna was dominated by Aricidean jeffreysii, a paraonid polycheate. A. jeffreysii is not a species commonly associated with polluted sediments. It is found on bottoms of fine sand/mud (Pettibone, 1963). Capitella sp. is the sub-dominant species. A. jeffreysii and Capitella sp. together make up 57 percent of the total sample abundance.

Shoreline and Waterfowl

Shorebird data for Lynn Harbor are limited and indicated heavy usage of the Point of Pines and central mussel shoal areas by the bird species dunlins and sanderlings (TASL, 1980). Spring, summer and fall uage by these and other species is undoubtedly greater than this single winter observation.

Many waterfowl overwinter in Lynn Harbor or migrate through in spring and fall. Data from 1979-1980 (H. Houseman, 1980, unpublished data) indicate heavy usage by scaup (25,529 sitings), eider (21,508), black ducks (6,560), bufflehead (1,412), goldeneye (761) and red-breasted merganser (286). Other species observed were brant, common merganser, horned grebe, mallard, harlequin, cormorant, hooded merganser, and loons. Most species made heaviest use of the Nahant causeway shore from Little Nahant south, although scuap and eider often rafted in the south-central harbor; fish-eating species (mergansers, cormorants) aggregated near the rivermouth; and brant and black ducks also used the Revere Beach-Point of Pines area. None of these species are either State or Federally-listed as threatened or endangered and their concentrations are heavier on the east side of the harbor outside of the project area.

Marine Mammals

Lynn Harbor is utilized as a winter feeding/resting area by harbor seals.

Threatened and Endangered Species

No species which occur in the study area are threatened or endangered at this time. Three species which are endagered might stray in to the harbor in the course of migratory behavior. These are:

1. Peregrine falcon: known to overwinter in Boston on large public buildings, feeding on rock doves.

2. Bald eagle: has been observed in migration.

3. Short-nosed sturgeon: last recorded at Provincetown, Massachusetts in 1907.

The study area does not provide critical or even suitable habitat for any of these species. Endangered large whales and sea turtles may occur off Nahant, but would not be expected to utilize the Lynn Harbor area (Douglas Beach, NMFS: Personal Communication, May 1984).

Historical and Archaeological Resources

Numerous prehistoric archaeological sites have been reported within the area of Revere Beach, and portions of the area saw considerable commercial and residential activity in the late 19th century. However, the shorefront zone to be affected by this project is not expected to contain significant historical or archaeological resources, due to erosion and modern construction activity.

Recreation

Point of Pines is located immediately north of the Revere Beach Reservation, an MDC facility which incorporates a 3-mile long sandy beach open to public use since 1895. Convenient access is provided by an adjacent mass transit railway stop. Revere Beach is a popular public recreation facility for the Boston metropolitan area, and included at one time an amusement park, many refreshment centers, arcades and restaurants. The area is now being restored under a master plan started in 1978. The master plan proposes new residential and commercial development and a linear park system, incorporating traffic improvments, as well as restoration of historic structures to accommodate food concessions, sanitary facilities, bathhouses, amusements, police and maintenance requirements.

Water Quality

The coastal waters of Revere, including Broad Sound, are subject to highly variable water quality conditions. Water quality samples taken by the Metropolitan District Commission each summer at Revere Beach have usually been rated at less than 100 MPN (most probable number of E. coli per 100 ml). This rating makes the area suitable for swimming. However, Lynn Harbor, which adjoins Broad Sound, is the location of a city of Lynn raw sewage outfall which discharges 20 million gallons per day. The discharge at Lynn, as well as a discharge at Nahant, make the Broad Sound area unsuited for harvesting of shellfish. Only upstream areas on the Pines River are suitable for shellfish harvesting, and then only with proper purification.

IV. ENVIRONMENTAL CONSEQUENCES

Principal environmental effects of a structural plan are a direct result of construction of the rock slope revetment, restoration of existing sand dunes beach nourishment/replenishment and construction of the concrete seawall adjacent to Rice Avenue. Construction activity associated with implementing a structural plan would result in a temporary increase in turbidity in local waters and a disruption of shoreline habitat. Turbidity increases are expected to have minimal short-term impact, as the shoreline is frequently subject to high levels of turbidity from storm wave action. Long term impacts would be the change in aquatic habitat in the area of rock, fill and some restriction of water views due to increasing the height of shore protection structures.

The proposed rock structure for Reaches A to D will cover approximately 1.0 to 1.5 acres of shorefront along the beach. This rock revetment will be built upon existing rock structures and seawalls and extend out 60 feet to 80 feet in to the forebeach and tidal zone. The eight-foot thick layer of armor stone would have a 1 on 3 slope down to the existing beach with the bottom of the slope being toed into the sand. This slope of the seaward face of the rugged rock revetment is too hazardous for public use. However, access to the beach will be maintained in these areas where public access currently exists. Access is currently limited by lack of public property along the Point of Pines shoreline here.

At Carey Circle and north to Reach D increasing the height of protection 1.5 feet will reduce the views of the beach and the water somewhat. Rock placed on the seaward side of the wall will eliminate a portion of the sandy beach. However, the area to be lost is a very small portion of the total available beach. Sand will be placed seaward of the rock revetment to replace the lost beach and provide toe protection.

The proposed sand dune restoration for Reach E would involve placement of 6,700 cubic yards of sand elevating the dunes to a uniform height of 14.3 feet NGVD, placement of sand fences, and vegetation planting with American Beach Grass (A Brevigulata) approximately 0.5 acres of dunes would be planted.

Environmental impacts associated with dune creation and revegation are predominantly those concerned with machinery employed during actual construction and personnel used in carrying out the planting. These impacts of noise, exhaust fumes, and physical compaction of beach sands by equipment and people are temporary and insignificant insofar as adverse impacts are concerned. There will be no irreversible impact to terrestrial animal or plant population or communities during the course of actual construction. When completed, the dune environment will provide an enhanced aesthetic scenery.

Wooden ramps would be constructed to provide access to the beach at the ends of each street. These ramps along with the sand fence extended along the dune crest would minimize undesirable foot traffic. These structures along with filling in the sand dune voids would reduce visual sights of the water. These reductions would not be significant.

A concrete seawall would be constructed along Reaches F and G. This wall would increase the existing wall by 8 inches in height and access would be provided by wood walkways. These structures would insignificantly reduce visual sights of the water. The entrance to the yacht club would be temporary sandbagged closed during flood conditions. The seawall would have aesthetic impacts. These are considered not significant, because of the existing seawall.

Placement of about 91,000 yds of revetment stone, sand, gravel and random fill would require an estimated 11,375 round trips by trucks from an undetermined quarry site to the construction site (assuming 10 yard trucks with 20% voids for an effective haulage of 8 yards). If construction takes 12 months over two years, there would be about 950 trips per month or about 45 trips per day (21 working days per month) during the working period. Since the area is presently congested and subject to frequent heavy traffic, this impact is also considered to be not significant.

Ecological Effects on Biological Resources

The US Fish and Wildlife Service reports (letter June 3, 1982) that the upper beach habitat, where construction is to take place "is sparsely populated with beach fleas, small crabs, sand dollars, shrimp and lance found in the intertidal zone. Spiders and a variety of insects inhabit the dunes which are covered with patches of beach grass and a few beach roses. The dunes receive little wildlife use during the summer because of the intense human activity, but migratory shorebirds, such as spotted sandpiper, sanderling, and semipalmated plover, will visit the dunes and beach late summer and early fall. It is a high tide roosting area for many birds representing most of these species.

The creation and restoration of sand dunes in this area would actually expand and enhance the natural habitat along that particular reach of the shoreline. The work proposed to protect residences consists of replacing or extending the existing riprap and concrete walls between Carey Circle and the dunes, and from the Point to the General Edwards Bridge, with a raised, pre-cast concrete seawall. There would be no long-term impact on fish and wildlife resources if these walls were replaced.

Shoreline Processes - Impacts on Sediment Transport

As part of the recommended plan, over 12 acres of beach would be added along the shore from Reaches A to E. This sand replenishment would not interfere with the natural supply or movement of sand and in fact would add new sand into the system. The new sediments would be redistributed by wave and tidal action. The degree of permanence of the beach is dependent upon seasonal and annual transport processes, storm frequencies and subsequent local maintenance.

The beach, in effect is a self-contained unit between Roughans Point to the south and the mouth of the Saugus River to the north at Point of Pines. Therefore, very little beach building material is added to the beach from outside sources, although small amounts of granually or sandy material may be added from an offshore base. The material in the beach is then subjected to some redistribution laterally along the beach, combined with offshore and onshore movement occuring during destructive high level storms (Army Corps Engr., 1968). During high intensity storm events or northeasters, the new sand placement may be expected to undergo significant movement. It will be the responsibility of local interests to maintain the beach area. During major storms sand transport will occur northeastly to the tip of Point of Pines. Accretion of the updrift is evident at Point of Pines. The sand then will have to be mechanically redistributed or bulldozed back to maintain the recreational beach.

The tidal influence of the Saugus River at its mouth and navigation entrance channel plays an important role in sand movement and distribution at the northern extremity of the beach. Although no specific studies have been performed, the impacts of any sand movements on the shoaling in the channel are expected to be minimal. The last major dredging of the Saugus River occurred in 1952. The relatively minor changes occuring since then and lack of the need to dredge suggest that the local velocities are sufficient to transport any materials out of the area. Beyond the intertidal zone the influence of tidal currents on local sediment transport is expected to progressively increase as a function of depth (Camp Dresser & McKee, 1978).

Endangered Species

The US Fish and Wildlife Service states (letter 15 June 1982) that "except for occasional transient individuals, no Federally listed or proposed species under our jurisdiction are known to exit in the project impact area. Therefore, no Biological Assessment or further consultation is required under Section 7 of the Endangered Species Act."

Historical and Archaeological Resources

Due to historic erosion and modern construction activity, no impacts are anticipated upon significant historic or archaeological resources as a result of this project. A letter from the Massachsuetts Historical Commission (dated 7 May 1982) confirms this determination.

Relationship of Project to Land and Beach Use Plans

The project does not conflict with existing or future land use plans for the Point of Pines area. The flood protection plan and dune restoration does not affect the coastal zone management or any local recreational development plans. The proposed project would not increase beach use demand nor provide for non-residents parking. The present beach use would continue. At present the Pine of Pines area is highly developed with little open space left to future growth.

Reaches A-D and Reaches F and G presently contain variations of concrete seawall construction and/or revetments. Proposed improvements in Reaches A-D would be a continuous stone revetment (1 vertical on 3 horizontal slope) on the ocean side of existing seawalls and revetment. Beach sand placement would be included in Reaches A-D to provide toe protection. About 1 acre of beach above MHW would be created. Access to beach would be included in the proposed plan.

Reach E consists of natural sand dunes which would be supplemented and renourished by beachgrass plantings and preserved as a natural protective barrier. This should improve the recreational function of a relatively extensive reach within the study area, and conforms with community desires for protection involving minimum beach loss. Wooden cross-walks would be constructed at the end of every street to provide access to the beach and prevent breaching of rebuilt dunes by future foot traffic. Rebuilding of dunes is considered to be an effective shore protection method for this area.

General Construction. Construction activities at Point of Pines would result in noise from the equipment. This would disturb the visitors to the beach and residences of the surrounding areas. All construction noise would terminate with the project completion.

The trucks and equipment to be used for transporting the sandfill would increase noise levels, minor air pollution emission and energy consumption. Emission of air pollutants and energy consumption would be insignificant and temporary. All of these impacts would be minimal and would terminate with project completion. Most of the construction could take place after mid September to minimize disruption of the summer beach use.

V. COORDINATION

This study is being coordinated directly with the USEPA, Fish and Wildlife Service, National Marine Fisheries Service, Mass. CZM office, Mass. DEQE and the city of Revere as well as other interested groups.

During March 1982 a public information brochure and questionnaire regarding our study of flood damage reduction for the Point of Pines section of Revere was sent out. Of the 425 quesionnnaires sent to residents of this area, 129 were returned for a response rate of about 30 percent. Although this is a rather low percentage it did allow us to obtain a general idea of the needs and desires of local residents.

Since the March 1982 survey, and during our evaluation process, meetings and correspondence with local officials have occurred to incorporate community objectives into our planning process. In June 1984 a public workshop was held at Point of Pines to present the selected plan to local interest and city officials and record their comments.

Questions or comments relevant to this assessment report should be directed to Mr. Russ Bellmer Impact Analysis Branch, New England Division, US Army Corps of Engineers, (617) 647-8142.

Prior to the commencement of any work, a public notice will be issued describing the proposed action plan. Comments by all interested persons and agencies may be submitted to the Corps for a thirty day period following release of this notice.

VI. RELATIONSHIP TO ENVIRONMENTAL REQUIREMENTS

Certain environmental requirements, executive orders, and other policies of the Federal, State, or local governments must be met in order to implement the selected plan. Table 1 presents these concerns and their relationship to the proposed plans which were studied in detail. Coordination is continuing on this study with appropriate State and Federal agencies.

COMPLIANCE WITH ENVIRONMENTAL PROTECTION STATUTES AND EXECUTIVE ORDERS
Point of Pines, Revere, Mass. Coastal Flood Protection Study

Statutes	Compliance
1. Archeological and Historic Preservation Act, as ammended, 16 U.S.C. 469 et seq.	No cultural or archaelogical resources would be impacted by the proposed action. (See letter in Section VIII from Massachusetts Historical Commission, 7 May 1982.)
2. Clean Air Act, as amended, 42 U.S.C. 7401 et seq.	Submission of this report to the Regional Administrator of the Environmental Protection Agency (EPA) for review constitutes compliance with Act. Construction vehicles will be equipped with proper emission control devices.
3. Clean Water Act (Federal Water Pollution Control Act), as amended, 33 U.S.C. 1251 et seq.	A water quality certificate under Section 401 of this Act must be granted by the State; a Section 404 (b) (1). Evaluation has been prepared for this project and is attached.
4. Coastal Zone Management Act of 1972, as amended, 16 U.S.C. 1451 et seq	The State CZM office will review of our proposal and must concur with our consistecy determination to fulfill compliance.
5. Endangered Species Act of 1973, as amended, 16 U.S.C. 1531 et seq.	Coordination with the National Marine and Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (FWS) constitutes compliance with this Act. (See letter of June 15, 1982)
6. Estuary Protection Act, 16 U.S.C. 1221 et seq.	Coordination of this document with the Department of Interior constitues compliance with this Act.
7. Federal Water Project Recreation Act, as amended, 16 U.S.C. 4601-12 et seq.	Same as above.
8. Fish and Wildlife Coordination Act, as amended, 16 U.S.C. 661 et seq.	Coordination of this document with the FWS and the NMFS constitutes compliance with this Act.
9. Land and Water Conservation Fund Act of 1965, as amended, 16 U.S.C. 4601-4 et seq.	Coordination with the Department of the Interior constitutes compliance with this Act.
10. Marine Protection, Research, and Sanctuaries Act of 1972, as amended, 33 U.S.C. 1404 et seq.	Not applicable
11. National Historic Preservation Act of 1966, as amended, 16 U.S.C. 470 et seq.	No cultural resources would be impacted by the proposed action. (See letter in Section VIII from Mass. Historical Commission, May 7, 1982.)
12. National Environmental Policy Act of 1969, as amended, 42 U.S.C. 432 et seq.	The preparation of this assessment document constitutes compliance with this Act.
13. Rivers and Harbors Appropriation Act of 1899, as amended, 33 U.S.C. 401 et seq. with this Act.	Full Compliance
14. Watershed Protection and Flood Prevention Act, as amended, 16 U.S.C. 1001 et seq.	Not Applicable.
15. Wild and Scenic Rivers Act, as amended, 16 U.S.C. 1271 et seq.	Not Applicable.
Executive Orders	
1. Executive Order 11988, Floodplain Management, 24 May 1977.	Full Compliance
2. Executive Order 11990, Protection of Wetlands, 24 May 1977.	Full Compliance
3. Executive Order 12114, Environmental Effects Abroad of Major Federal Actions, 4 January 1979.	Not Applicable.

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2. Chesmore, A.P., P.J. Brown, and R.D. Anderson, 1972. A Study of the Marine Resources of Lynn-Saugus Harbor; Division of Marine Fisheries, Monograph Services No. 11, p. 39.

3. Cortell, Jason M. and Associates Inc. 1980. Draft Environmental Assessment, COE Small Navigation Project Lynn Harbor, Massachusetts. Prepared for US Army Corps of Engineers. Oct. 1980.

4. Houseman, J.H., Waterfowl Biologist, Division of Fisheries and Wildlife, Massachusetts Department of Fisheries, Wildlife, and Recreational Vehicles, Westboro, MA. Personal Communication.

5. Normandeau Associates, Inc. 1980. Environmental Draft Report and Preliminary Evaluation of Proposed Navigation Improvements, Lynn Harbor, Massachusetts. Prepared for the New England Division, US Army Corps of Engineers, May 1980.

6. Raytheon Company, 1971. Lynn Harbor-Nahant Bay Ecological Survey Report, July-November, 1970. Prepared for the New England Electric Company, Westboro, MA.

7. Raytheon Company, 1973. Lynn Harbor-Nahant Bay Ecological Survey Report, January, 1972-December, 1972. Prepared for the New England Electric Company, Westboro, MA.

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9. U.S. Army Corps of Engr. 1968. Beach erosion control report an cooperatvie study of Revere and Nantucket Beaches, Mauachuise TB. New England Div., Army Corps of Engineer, Waltham, Mass. March 1968.

10. U.S. Army Corps of Engineers. 1982. Roughans Point Revere, Massachusetts Coastal Flood Protection Study. Water Resources Investigation Interim Report, Main Report - Volume I. December 1982 (Rev. Oct. 1983), New England Division, US Army Corps of Engineers.

11. VTN, 1979. Preliminary Water Quality Impact Assessment of Combined Sewer Overflows, August, 1979. VTN Consolidated, Inc. Boston, MA.

Finding of No Significant Impacts

Factors considered in the proposed coastal flood protection project at Point of Pines, Revere include the construction of a stone revetment 1,570 feet in length at top elevation 16.0 ft. NGVD from Reach A through D; a concrete wall 1,700 feet long along Reaches F and G at top elevation 13.3 ft. NGVD paralleling the Saugus River, and approximately 6,700 cubic yards of sand fill for beach and dune restoration in Reach E to top elevation 14.3 ft. NGVD. Evaluation of available information indicates that there should be no unacceptable environmental impacts.

This assessment has been prepared in accordance with the National Environmental Policy Act of 1969 and appropriate Army Corps of Engineers regulations. My determination that an Environmental Impact Statement is not required is based on the information contained in the Environmental Assessment and the following considerations:

(1) Structural measures will be made to reduce coastal flooding. The alternative of public no action would result in continued periodic flooding of the area with recurring damage to property and possible loss of life.

(2) The placement of rock and sandfill will not result in the loss of any important shellfish habitat or significant biological resource nor effect adversely exisiting water quality.

(3) The proposed construction of the revetment and wall will cover approximately 2.0 to 2.5 acres of shorefront along the beach. Sand will be placed seaward of the rock revetment to provide toe protection and result in about 1 acre of beach above MHW.

(4) The U.S. Fish and Wildlife Service has stated (letter January 19, 1983) that "none of the proposed structural options will have significant adverse impacts upon fish and wildlife resources. However, there would be minor biological losses from disturbances during construction and shore and beach habitat covered by revetments."

(5) The proposed plan would not involve significant wetlands (e.g., saltmarsh), or affect any endangered species or cultural resources.

(6) Coordination with appropriate Federal and State agencies insured that concerns and suggestions were made known to the Corps and these concerns were incorporated into the planning process. These agencies expressed no overriding environmental issues associated with this project.

(7) Proposed construction would not preclude and future land use alternatives.

There does not appear to be any major environmental problem, conflict or disagreement in implementing the proposed work. I have determined that implementation of the proposed action would not have a significant adverse impact on the human environment and that it does not constitute a major Federal action requiring the preparation of an Environmental Impact Statement.

Based on the information contained in this environmental assessment, it is my conclusion that development of the proposed plans for Point of Pines will not require a significant commitment of physical, natural or human resources, nor have any significant impacts which would necessitate the preparation of an Environmental Impact Statement.

DATE

CARL B. SCIPLE
Colonel, Corps of Engineers
Division Engineer

NEW ENGLAND DIVISION
U.S. ARMY CORPS OF ENGINEERS WALTHAM, MA.

PROJECT POINT OF PINES COASTAL FLOOD PROTECTION STUDY - REVERE, MASSACHUSETTS

PROJECT MANAGER MR. JOE BOCCHINO EXT. 557

FORM COMPLETED BY MR. RUSS BELLMER EXT. 142

PROJECT DESCRIPTION:

The recommended plan would utilize three distinctly different types of construction in the seven reaches of Point of Pines. These include:

(1) Stone revetment and beach sand replenishment along Reaches A to D. This portion of the project study area includes Carey Circle to Alden Avenue. Approximately 30,000 cubic yards of sand will be trucked in from a landbased source site for placement over the toe of the revetment structures. The proposed revetment would start with a transition section in Reach A having a top elevation gradually increasing to 16.0 feet NGVD, with a 1:3 slope down to the existing beach. The grade would be gradually reduced from Chamberlain to Alden Avenues to 14.5 feet NGVD (400 linear feet) where it meets with Reach E. The sandfill will be distributed down to the -2.6-foot NGVD contour. Mean low water is at elevation -4.6 feet NGVD.

(2) Sand dune and beach sand replenishment, beach grass planting, snow fences and wooden walkways along Reach E. This portion of the study extends from Alden Avenue to the mouth of the Saugus River. The top elevation along the existing sand dunes varies from 12.1 to 16.6 feet NGVD with the low points generally confined to short areas near the ends of several streets, where pedestrian traffic to the beach generally "wears down" the dunes. During the February 1978 Blizzard it was reported that overtopping of the dunes occurred only in these low areas. The proposed plan would include raising the existing dunes to elevation 14.3 feet NGVD and filling in these gap areas. An estimated 6,700 cubic yards of sand fill will be required. In order to allow for access to the beach, wooden ramps would be constructed over the dunes at the end of streets. In addition, a "sand" fence would extend along the crest to capture sand and minimize undesirable foot traffic.

(3) Seawall along Reaches F and G. The recommended plan proposes to provide a concrete wall with a top elevation at 13.3 feet NGVD. This new wall would only be about 8 inches higher than the existing wall. Like the other reaches, access to the beach would be provided by walkways over the protection where access currently exists. The entrance to the Yacht Club would be sandbagged during flood conditions.

The recommended plan will prevent 97% of the average annual damages and is designed to withstand the 100-year storm event. Approximately 29,000 cubic yards of armor stone, 16,000 cubic yards of underlayer stone and 9,000 cubic yards of bedding stone will be required for the revetment walls. It is estimated that the construction time to complete the project will require two years.

NEW ENGLAND DIVISION
U.S. ARMY CORPS OF ENGINEERS WALTHAM, MA

PROJECT POINT OF PINES COASTAL FLOOD PROTECTION STUDY
REVERE, MASSACHUSETTS

SHORT-FORM
Evaluation of Section 404(b)(1) Guidelines

1. Review of Compliance (Sect. 230.10(a)-(d) Preliminary Final (circle one)

a. The discharge represents the least environmentally damaging practical alternative and if in a special aquatic site, the activity associated with the discharge must have direct access or proximity to, or be located in the aquatic ecosystem to fulfill its basic purpose (if no, see section 2 and information gathered for EA alternative); YES [X] NO [ ]

b. The activity does not appear to: 1) violate applicable state water quality standards or effluent standards prohibited under Section 307 of the CWA; 2) jeopardize the existence of Federally listed endangered species or their habitat; and 3) violate requirements of any Federally designated marine sanctuary (if no, see section 2b and check responses from resource and water quality certifying agencies); YES [X] NO [ ]

c. The activity will not cause or contribute to significant degradation of waters of the U.S. including adverse effects on human health, life stages of organisms dependent on the aquatic ecosystem, ecosystem diversity, productivity and stability, and recreational, aesthetic, and economic values (if no, see section 2); YES [X] NO [ ]

d. Appropriate and practicable steps have been taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem (if no, see section 5). YES [X] NO [ ]

Proceed to Section 2

*1/, 2/ See page 6

2. Technical Evaluation Factors (Subparts C-F).

	N/A	Not Significant	Significant
a. Physical and Chemical Characteristics of the Aquatic Ecosystem (Subpart C).			
1) Substrate impacts		X	
2) Suspended particulates/turbidity impacts.		X	
3) Water column impacts.		X	
4) Alteration of current patterns and water circulation		X	
5) Alteration of normal water fluctuations/hydroperiod		X	
6) Alteration of salinity gradients.	X		
b. Biological Characteristics of the Aquatic Ecosystem (Subpart D).			
1) Effect on threatened/endangered species and their habitat.	X		
2) Effect in the aquatic food web.		X	
3) Effect on other wildlife (mammals, birds, reptiles and amphibians).		X	
c. Special Aquatic Sites (Subpart E).			
1) Sanctuaries and refuges.	X		
2) Wetlands		X	
3) Mud flats		X	
4) Vegetated shallows	X		
5) Coral reefs	X		
6) Riffle and pool complexes	X		
d. Human Use Characteristics (Subpart F).			
1) Effects on municipal and private water supplies.	X		
2) Recreational and Commercial fisheries impacts.		X	
3) Effects on water-related recreation.		X	
4) Aesthetic impacts.		X	
5) Effects on parks, national and historic monuments, national seashores, wilderness areas, research sites, and similar preserves.	X		

Remarks: Where a check is placed under the significant category, preparer add explanation below.

Proceed to Section 3

*See page 6

3. Evaluation of Dredged or Fill Material (Subpart C).

a. The following information has been considered in evaluating the biological availability of possible contaminants in dredged or fill material (Check only those appropriate).

1) Physical characteristics.................................... [X]
2) Hydrography on relation to known or anticipated sources of contaminants.............................. [ ]
3) Results from previous testing of the material in the vicinity of the project... [ ]
4) Known, significant sources of persistent pesticides from land runoff or percolation....................................... [ ]
5) Spill records for petroleum products or designated (Section 311 of CWA) hazardous substances.. [ ]
6) Other public records of significant introduction of municipalities or other sources... [ ]
7) Known existence of substantial material deposits of substances which could be released in harmful quantities to the aquatic environment by man-induced discharge activities..................... [ ]
8) Other sources (specify)............................. [ ]

List appropriate references.

The material will be obtained from a commercial quarry site.

b. An evaluation of the appropriate information in 3a above indicates that there is reason to believe the proposed dredge or fill material is not a carrier of contaminants, or that levels of contaminants are substantively similar at extraction and disposal sites and not likely to constraints. The material meets the testing exclusion criteria. YES [X] NO [ ]

Proceed to Section 4

*See page 6.

4. Disposal Site Delineation (Sect. 230.11(f))

a. The following factors as appropriate, have been considered in evaluating the disposal site.

1) Depth of water at disposal site....................... [X]
2) Current velocity, direction, and variability at disposal site....................... [X]
3) Degree of turbulence....................... [X]
4) Water column stratification....................... [ ]
5) Discharge vessel speed and direction....................... [ ]
6) Rate of discharge....................... [X]
7) Dredged material characteristics (constituents, amount, and type of material, settling velocities)....................... [X]
8) Number of discharges per unit of time....................... [X]
9) Other factors affecting rates and patterns of mixing (specify)....................... [ ]

List appropriate references.

b. An evaluation of the appropriate factors in 4a above indicates that the disposal site and/or size of mixing zone are acceptable....................... YES [X] NO [ ]

5. Actions to Minimize Adverse Effects (Subpart 11).

All appropriate and practicable steps have been taken, through application of recommendation of Sect. 230.70-230.77 to ensure minimal adverse effects of the proposed discharge. List actions taken. YES [X] NO [ ]

All material will be obtained from a commercial quarry site. All material will be coarse sand grain size and placed to -2.6 feet NGVD.

N.B. Return to section 1 for final stage of compliance review.

*See page 6

6. Factual Determination (Sect. 230.11)

A review of appropriate information as identified in items 2-5 above indicates that there is minimal potential for short or long term environmental effects of the proposed discharge as related to:

a. Physical substrate at the disposal site (review sections 2a, 3, 4, and 5 above).	YES [X]	NO [ ]
b. Water circulation, fluctuation and salinity (review sections 2a, 3, 4, and 5).	YES [X]	NO [ ]
c. Suspended particulates/turbidity (review sections 2a, 3, 4, and 5)	YES [X]	NO [ ]
d. Contaminant availability (review sections 2a, 3,and 4)	YES [X]	NO [ ]
e. Aquatic ecosystem structure and function (review sections 2b and c, 3, and 5)	YES [X]	NO [ ]
f. Disposal site (review sections 2, 4, and 5)	YES [X]	NO [ ]
g. Cumulative impact on the aquatic ecosystem	YES [X]	NO [ ]
h. Secondary impacts on the aquatic ecosystem	YES [X]	NO [ ]

7. Findings

a. The proposed disposal site for discharge of dredged or fill material complies with the Section 404(b)(1) guidelines.. [X]

b. The proposed disposal site for discharge of dredged or fill material complies with the Section 404(b)(1) guidelines with the inclusion of the following conditions.... [ ]

*See page 6

c. The proposed disposal site for discharge of dredged or fill material does not comply with the Section 404(b)(1) guidelines for the following reasons:

1) There is a less damaging practicable alternative.......... ☐

2) The proposed discharge will result in significant degradation of the aquatic ecosystem..................... ☐

3) The proposed discharge does not include all practicable and appropriate measures to minimize potential harm to the aquatic ecosystem.................. ☐

DATE

CARL B. SCIPLE
Colonel, Corps of Engineers
Division Engineer

FOOTNOTES

*A negative, significant or unknown response indicates that the proposed project may not be in compliance with the Section 404(b)(1) Guidelines.

1) Negative responses to three or more of the compliance criteria at this stage indicate that the proposed projects may not be evaluated using this "short form procedure". Care should be used in assessing pertinent portions of the technical information of items 2 a-e, below before completing the final review of compliance.

2) Negative response to one of the compliance criteria at this stage indicates that the proposed project does not comply with the guidelines. If the economics of navigation and anchorage of Section 404(b)(2) are to be evaluated in the decision-making process, the "short form evaluation process is inappropriate".

VIII CORRESPONDENCE

COASTAL ZONE
MANAGEMENT

The Commonwealth of Massachusetts
Executive Office of Environmental Affairs
100 Cambridge Street
Boston, Massachusetts 02202

October 4, 1984

Colonel Carl B. Sciple
U.S. Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02254

Re: CZM Consistency Review: Point of Pines Flood Protection, Revere, Massachusetts

Dear Colonel Sciple:

The Massachusetts Coastal Zone Management (MCZM) Office has completed its review of the preliminary plans for the Point of Pines Flood Control Project and we agree with your consistency determination.

You should be aware that any changes to this project, either design modifications or cost sharing (presently it is entirely federal funded), must be submitted to this Office for a new consistency review.

I would like to take this opportunity to express my pleasure in the Corps' proposed use, in part, of beach and dune nourishment for purposes of coastal flood protection.

I sincerely hope that this type of management strategy will continue to be implemented where appropriate.

Sincerely,

Richard F. Delaney

Richard F. Delaney
Director

RFD/JB:sla

The Commonwealth of Massachusetts
Executive Office of Environmental Affairs
100 Cambridge Street
Boston, Massachusetts 02202

COASTAL ZONE
MANAGEMENT

August 16, 1984

Carl B. Sciple
Colonel, Corps of Engineers
424 Trapelo Road
Waltham, MA 02154

Re: CZM Consistency Review: Point of Pines Flood Protection
Revere, Massachusetts

Dear Colonel Sciple:

The Massachusetts Coastal Zone Management Office has received your consistency determination for the proposed flood protection project at Point of Pines, Revere, Massachusetts. Notice of this proposal will be published in the August 22, 1984 edition of the <u>Environmental Monitor</u>.

Enclosed please find a copy of the schedule that we will follow during our consistency review. Although we have sixty days in which to review your determination and concur with it or object to it, we make a vigorous effort to complete our review shortly after the close of the comment period.

Please call me at 727-9530 if you have any questions about the review process.

Sincerely,

Marianne Connolly

Marianne Connolly
Project Review Coordinator

MC:dc
Enclosure

cc: Revere Conservation Commission

Consistency Review Schedule
for a Federal Activity*

REVIEW STEP	DATE
1. Received the consistency determination from agency on	August 13, 1984
2. Submitted for publication in earliest possible Environmental Monitor (either the 31st or the 15th of the month)	August 15, 1984
3. Notice inviting comments and opening 21 day comment period will appear in Environmental Monitor on (either the 8th or the 22nd of the month	August 22, 1984
4. Comment period closes	September 12, 1984
5. Last day to inform agency of review status or request extension (45 days from Step 1)	September 27, 1984
6. Last day of extension review period closes	October 12, 1984

U.S. Army Corps of Engineers
Point of Pines, Revere, MA
Flood Protection Project

*Section 7.13 MCZM Regulations

United States Department of the Interior

FISH AND WILDLIFE SERVICE
ECOLOGICAL SERVICES
P.O. BOX 1518
CONCORD, NEW HAMPSHIRE 03301

Colonel Carl B. Sciple
Division Engineer
U.S. Army Corps of Engineers
New England Division
424 Trapelo Road
Waltham, MA 02254

JUN 27 1984

Dear Colonel Sciple:

This letter is a supplement to our Planning-Aid letter of January 19, 1983, concerning flood control measures at Point of Pines in Revere, Massachusetts. It has been prepared under the authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

We understand that of the alternatives considered, the most likely plan to be selected for the seven reaches extending from Carey Circle to General Edwards Bridge is as follows:

Reaches A-D (1,530 feet). Rock revetment on ocean side of existing seawalls and beach sand replenishment (9-11 thousand cubic yards) to form dry beach area in front of revetment.

Reach E (1,720 feet). Raise existing sand dunes to elevation 14.3 NGVD and plant beach grass to stabilize the area. Approximately 35,000 cubic yards of sandfill would be required. Wooden cross-walks would be constructed across the dunes to prevent breaching by foot traffic.

Reach F(970 feet). Replace existing precast seawall structure with a new concrete wall.

Reach G(730 feet). A new concrete wall along the property line of the Point of Pines Yacht Club to General Edwards Bridge.

In our opinion, none of these proposed structural measures will have significant adverse impacts upon fish and wildlife resources. The rock revetment in Reaches A-D would result in a minor loss of beach habitat. The proposed sandfill in this area would be well above the MLW line and all sand would be from a suitable land source. Benthic or other subterranean organisms occupying the sandfill site may be destroyed through burial, mechanical damage or other means. This benthic fauna should reestablish within a few growing seasons. Placement of sand during the late fall to early spring period will reduce adverse impacts upon these organisms.

Rebuilding the sand dunes in Reach E would disrupt existing habitat, however, adverse impacts would be of short duration. Placement of sandfill during the late fall to early spring period would be the least disruptive to the wildlife community. Over the long term stabilizing the dune area would result in a net environmental benefit. All sandfill would be from a suitable land source.

The new concrete walls proposed for areas F and G are above the MHW line and construction would have no significant impact upon fish and wildlife resources.

We would be pleased to assist you in the various stages of project planning, and we will report on the potential impacts of your selected plan.

Sincerely yours,

for Vernon B Kerry

Gordon E. Beckett
Supervisor
New England Field Office

THE CITY OF
REVERE, MASSACHUSETTS

OFFICE OF THE MAYOR
CITY HALL

GEORGE V. COLELLA
MAYOR

May 30, 1984

Dear Point of Pines Residents:

Over the past two years, the U.S. Army Corps of Engineers have been conducting studies and investigations for a flood protection plan in the Point of Pines area. The extent of shoreline protection being studied begins at Carey Circle runs northeasterly and westerly along Rice Avenue to the General Edwards Bridge.

The Corps has evaluated a number of flood protection plans for the Pines area with respect to their degree of economic and technical feasibility. Subsequent to these prior evaluations and a number of workshop meetings held with residents and City Officials, the Corps has formulated a flood protection plan which provides a high degree of protection (100 year flood event) while being sensitive to the design impact concerns and beach user needs of the residents.

The plan being proposed by the Corps, involves a combination of four measures of shoreline protection at various locations between Carey Circle and the General Edwards Bridge including: 1)rock revetment; 2)seawall improvements; 3)beach replenishment; and 4)dune restoration. An overview and description of this plan has been attached for your information and comments. You are urged to bring your written comments to a meeting co-sponsored by the City of Revere and Army Corps of Engineers to be held on Wednesday evening, June 27, 1984 at 7:00 p.m. in the Saint John Vianney Church Hall in the Point of Pines.

As this may be the final meeting concerning the proposed Point of Pines flood protection plan to be conducted by the Corps of Engineers and the City of Revere, it is most important that you make an effort to attend and record your comments. The deadline for receiving comments will be July 6, 1984 and should be submitted on the attached comment sheet and addressed to Mr. Frank Stringi, Department of Planning and Community Development, Revere City Hall, Revere, Massachusetts 02151.

If you have any questions concerning the attached plan prior to the June 27, 1984 meeting you should contact Mr. Frank Stringi at 284-3600, Ext. 111 or Corps Project Manager, Mr. Richard Zingarelli at (617) 647-8557.

Very truly yours,

George V. Colella
Mayor

GVC/vg

Attachment

United States Department of the Interior

FISH AND WILDLIFE SERVICE
ECOLOGICAL SERVICES
P.O. BOX 1518
CONCORD, NEW HAMPSHIRE 03301

Colonel Carl B. Sciple
Division Engineer
U.S. Army Corps of Engineers
New England Division
424 Trapelo Road
Waltham, Massachusetts 02254

JAN 19 1983

Dear Colonel Sciple:

This planning-aid letter is intended to aid your study planning efforts for the development of flood control measures at Point of Pines in the Town of Revere, Suffolk County, Massachusetts. It has been prepared under the authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

We understand that the proposed structural options for the seven (7) reaches extending from Cary Circle to General Edwards Bridge are as follows:

Reach A (230 ft.)

1. Rock revetment around existing concrete wall at Carey Circle.

Reach B (460 ft.)

1. Move rock revetment inland to patio walk and raise seaward edge of berm maximum of three feet or (2) concrete wall with rock revetment.

Reach C (450 ft.)

1. Replace existing concrete wall with rock revetment or (2) concrete revetment with rock toe.

Reach D (480 ft.)

1. Rock revetment and toe for existing concrete wall.

Reach E (1720 ft.)

1. Place rock revetment under sand dunes, replace sand dunes and stabilize with beach grass or (2) concrete wall along Rice Avenue or under sand dunes.

Reach F (970 ft.)

1. Replace existing concrete wall with earth dike or (2) new concrete wall.

Reach G (730 ft.)

1. Earth dike or (2) concrete wall along Saugus River outside of MHW line to General Edwards Bridge.

We believe that none of the proposed structural options will have significant adverse impacts upon fish and wildlife resources. However, there would be minor losses from disturbance during construction, and from shore and backyard habitat covered by revetments, concrete walls or earthen dikes. These minor losses could be reduced in selected reaches by choosing the structural option that would cause the least disturbance and loss of habitat. Our recommended option for these reaches are as follows:

Reach B - Move rock revetment inland.

Reach C - Concrete revetment with rock toe.

Reach E - Concrete wall along Rice Avenue.

Reach F and G - Concrete wall.

In addition, we recommend that public access to the beaches be maintained whenever it is available, and that measures to confine people to certain walkways be provided to prevent dune erosion.

We appreciate the opportunity to report on your plans, and we will prepare a final report as soon as you advise us of the selected plan.

Sincerely yours,

M. Mikolaitis

for Gordon E. Beckett
Supervisor

United States Department of the Interior

FISH AND WILDLIFE SERVICE
ECOLOGICAL SERVICES
P.O. BOX 1518
CONCORD, NEW HAMPSHIRE 03301

JUN 23 1982

Division Engineer
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02254

Dear Sir:

This letter is intended to aid in your study of possible flood control measures for Point-of-Pines, Revere, Massachusetts. It is submitted in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

The work proposed to protect residences at the Point consists of replacing the existing riprap and concrete walls between Carey Circle and the dunes, and from the Point to the General Electric Bridge, with higher and wider earth and stone dikes. There will be no long-term impact on fish and wildlife resources if these walls are replaced.

About 1,720 feet of sand dunes just south of the tip of the Point will be removed, the rock dike continued to the Point, and the dunes replaced. The upper beach habitat is sparsely populated with beach fleas, while small crabs, sand dollars, shrimp and sand lance are found in the intertidal zone. Spiders and a variety of insects inhabit the dunes which are covered with patches of beach grass and a few beach roses. The dunes receive little wildlife use during the summer because of the intense human activity, but migratory shorebirds, such as spotted sandpiper, sanderling, and seimpalmated plover, will visit the dunes and beach during late summer and early fall. It is a high tide roosting area for many birds representing most of these species.

The proposed 1,080-foot dike between Lynn Way and North Shore Road will eliminate backyard songbird habitat along some of the 1,080-foot length. There seems to be no mitigation possibilities, but damage should be kept to a minimum and the area replanted to shrubs and trees where feasible to replace the habitat for such songbirds as robins, housefinchs, catbirds and others.

We believe that none of the proposed alternate plans will have significant impacts upon fish and wildlife resources. However, there would be minor losses from disturbance during construction, and from the shore and backyard habitat covered by the dikes. We recommend that public access to the beaches be maintained wherever it is available, that measures to confine people to certain walkways be provided to prevent dune erosion, and that the dunes be revegetated.

cc: CE - R. Hunt

We appreciate the opportunity to report on your plans, and we will prepare a final report as soon as you advise us of the selected plan.

Sincerely yours,

Gordon E. Beckett

Gordon E. Beckett
Supervisor

cc: CE, Robert Hunt

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

New England Area Office
P.O. Box 1518
Concord, N.H. 03301

JUN 15 1982

Colonel William E. Hodgson
Deputy Division Engineer
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02254

Dear Colonel Hodgson:

We are sending you endangered species information to assist you in planning for flood control at Point of Pines, Revere Beach, Massachusetts.

Our review shows that except for occasional transient individuals, no Federally listed or proposed species under our jurisdiction are known to exist in the project impact area. Therefore, no Biological Assessment or further consultation with us is required under Section 7 of the Endangered Species Act. Should project plans change, or if additional information on listed or proposed species becomes available, this determination may be reconsidered.

This response relates only to endangered species under our jurisdiction. It does not address other legislation or our concerns under the Fish and Wildlife Coordination Act.

Sincerely yours,

Gordon E. Beckett

Gordon E. Beckett
Acting Area Manager

cc: CE, Robert Hunt

THE CITY OF
REVERE, MASSACHUSETTS

OFFICE OF THE MAYOR
CITY HALL

GEORGE V. COLELLA
MAYOR

June 1, 1982

Colonel C.E. Edgar, III
Division Engineer
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02254

Dear Colonel Edgar:

My sincere appreciation for your efforts to develop plans to protect the Point of Pines area in Revere which was severely damaged in the record flood of 1978. Two public workshops and a public survey were conducted to present both structural and nonstructural flood control measures.

Residents have voiced a preference for a structural plan, specifically the Intermediate Flood (IMF) control structural plan rather than the higher level of protection offered by the Standard Project Northeaster (SPN) plan. The SPN plan requires a very high wall of rock and earth around the community which would create a prison-like appearance. The $6.7 million SPN plan is also less cost effective than the $3.8 million IMF plan since they both offer about the same economic benefits.

I support the IMF plan for more detailed study since it maximizes economic benefits, provides a high level of protection (exceeding the 1978 event) and has less impact on the community when compared to the other structural and nonstructural plans. I understand that the next and final planning stage will consider further the options of concrete walls in lieu of revetments and dikes at a few locations as well as other measures to reduce the impacts of the preliminary IMF plan on beach area, visibility and aesthetics within the neighborhood.

Since the cost of the IMF plan is considerably lower than the SPN plan, the $3.8 million plan is eligible for implementation under the Corps Continuing Authority of Section 205. If funds are available under this small projects program, I request that the Point of Pines study be pursued under Section 205 since it would expedite study completion, project authorization and construction. It is understood that the non-Federal cost of the $3.8 million plan under Section 205 will include the contribution of lands, easements and rights of way necessary for project construction, and project maintenance after construction.

Very truly yours,

George V. Colella

George V. Colella
Mayor

GVC/lf

cc: Senator Paul E. Tsongas
Congressman Edward J. Markey
Frank Stringi DPCD

MASSACHUSETTS
HISTORICAL
COMMISSION

COMMONWEALTH OF MASSACHUSETTS
Office of the Secretary of State
294 Washington Street
Boston, Massachusetts
02108
617-727-8470

MICHAEL JOSEPH CONNOLLY
Secretary of State

May 7, 1982

Mr. Joseph L. Ignazio
Chief, Planning Division
Department of the Army
Corps of Engineers
424 Trapelo Rd.
Waltham, MA. 02254

Re: Revere Coastal Flood Protection Study - Point of Pines

Dear Mr. Ignazio:

Thank you for supplying the Massachusetts Historical Commission with information with your letter of April 26, 1982. MHC staff have reviewed the proposed Coastal Flood Protection Study at Point of Pines in Revere. MHC feels that this project is unlikely to affect significant historic or archaeological resources. No further review in compliance with Section 106 of the National Historic Preservation Act of 1966 is required.

If you have any further questions, please feel free to call Brona Simon of the MHC staff.

Sincerely,

Patricia L. Weslowski

Patricia L. Weslowski
State Historic Preservation Officer
Executive Director
Massachusetts Historical Commission

xc: John Wilson, Army Corps of Engineers

MARKEY
MASSACHUSETTS

COMMITTEES:

ENERGY AND COMMERCE

INTERIOR AND INSULAR AFFAIRS

CHAIRMAN
COMMITTEE ON OVERSIGHT AND INVESTIGATIONS

COPY

Congress of the United States
House of Representatives
Washington, D.C. 20515

403 CANNON HOUSE OFFICE BUILDING
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BOSTON, MASSACHUSETTS 02203
(617) 223-2781

464B SALEM STREET
MEDFORD, MASSACHUSETTS 02155
(617) 396-4600

4 March 1982

Colonel C. E. Edgar, III
U.S. Army Corps of Engineers
424 Trapelo Road
Waltham, MA 02154

Dear Colonel Edgar:

I am writing to again express my strong concern for and interest in the coastal flooding study the Corps is undertaking for Revere, Massachusetts, particularly the Point of Pines, Revere Beach and Backshore areas.

It is my hope that the study could be accelerated to reduce the potential damage of another devastating storm before the work is completed. In order to accomplish this, I would support increasing the funding level for the studies of the Point of Pines, Revere Beach and Backshore areas, if you felt that your division had the capability to use the additional funding in fiscal year 1983. Specifically, I would want to know how much additional money, if any, you could successfully expend on any or all of these areas.

Let me reiterate my concern for the safety of the Revere Shoreline and my commitment to assist the Corps and the city of Revere with its longterm protection.

I await your response and look forward to working with you.

Sincerely,

Ed Markey

EDWARD J. MARKEY
Member of Congress

EJM/kgs

Address reply to: Room 2100A
John F. Kennedy Federal Building
Boston, Massachusetts 02203

THE CITY OF
REVERE, MASSACHUSETTS

OFFICE OF THE MAYOR
CITY HALL

GEORGE V. COLELLA
MAYOR

February 8, 1982

Colonel C.E. Edgar, III, Division Engineer
Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Colonel Edgar:

Today marks the 4th anniversary of the "Great Blizzard of 1978," and as the seas appear calm on this day, the memory remains strong in the minds of many who saw the full force of the Atlantic Ocean engulf their property four years ago. Although this was an event that will never be forgotten by those who endured it, the effort of the Army Corps of Engineers, remains, for the residents of the City of Revere, the only glimmer of hope for protection against a re-occuring event. As such, I wish to, in order of priority, endorse the following proposed changes to the scope, schedules and priorities for the remaining Revere study effort, in order to implement a more viable plan for flood protection.

1. I strongly support the revision of the backwater protective alignment for the Roughan's Point Study as the highest priority, as it will increase the benefit impact on the hardest hit section of the City.

2. I concur with increasing the Fiscal Year 1983 scheduling funds for Stage 3 of the Point of Pines Study to include subsurface investigations which are necessary to identify the most cost effective plan for the Point of Pines area.

3. I concur that the Revere Beach Area (which effects some 1300 homes and businesses) include Stages 2 and 3 planning for Crescent Beach, Wonderland, Oak Island, Revere Beach North and Riverside and that this all important comprehensive effort be scheduled to start as soon as possible.

4. I support the Stage 1 studies for the Backshore Areas which affects some 1000± homes and businesses in Revere plus 1000± in Boston, Lynn, Saugus and Malden. The backshore areas comprise the Town Line Brook Area, areas bordering tidal marsh, Belle Isle Inlet, and areas with common plans for protection in Malden, Lynn, Boston and Saugus. The areas associated with the backshore have been subject to numerous complaints during 5 year storm flood events. I support all efforts geared to start these studies as soon as possible.

5. Finally, I support the goal that a level of protection be established for preparation of Roughans Point for a Standard Project Northeaster as soon as possible.

I cannot stress strongly enough our support of these study efforts and our desire to see them proceed without delay. While we, as city officials, can appreciate the work and effort expended by the Corps on the City of Revere's behalf, and are cognizant of the time constraints and statutory limitations that are imposed upon the Corps procedures, we must remember that flood protection studies for Revere's coastal areas first commenced in 1970. It is thus difficult for those directly affected time and time again by coastal flooding to comprehend the seemingly interminable delays and endless studies.

The shorefront property owner who has suffered through three major flooding episodes in the past ten years, cares little for studies but seeks to witness real protective measures; he looks back over the past 12 years of reports and wonders when construction will take place that will secure his life and his property. He knows that only the federal government has the resources necessary, but he wants to know when it will happen.

For these reasons, I reiterate our total endorsement of the Corps' recommendations and urge that everything possible be done so that these efforts can proceed immediately.

Very truly yours,

George V. Colella
Mayor

GVC/lf

cc: Paul Rupp, Director
Revere Journal
Lynn Item

ACKNOWLEDGEMENTS

The New England Division (NED), U.S. Army Corps of Engineers prepared this report under the overall direction of Colonel Carl B. Sciple, Division Engineer and Joseph L. Ignazio, Chief of the Planning Division. The Plan Formulation Branch (PFB) of the Planning Division has overall responsibility for the study under the supervision of its Chief, F. William Swaine. Study management is provided by the Special Programs Section.

Study team members include:

Joseph A. Bocchino - Project Manager, 1 Aug 84 to present

Richard R. Zingarelli - Project Manager, prior to 1 Aug 84

John E. Kennedy - Nonstructural Analysis

Diana L. Halas - Social Assessment and Base Conditions

Earl O. Perkins - Damage Sampling

Mark P. DeSouza - Economic Analysis

Russell J. Bellmer - Environmental Assessment

Edward J. Fallon - Real Estate Studies

Pat Tornifoglio - Structural Design

Anthony R. Riccio - Coastal Engineering

Jim Blair - Geotechnical Engineering

Charles W. Wener - Hydraulic Analysis

Renzo P. Michielutti - Hydrologic Investigations

This report was prepared for publication by NED's Word Processing Center under the supervision of Patricia A. Wysocki.

Thanks are extended to the city of Revere's Department of Planning and Community Development. Frank Stringi and Paul Rupp helped significantly with the study's public involvement program.

The Metropolitan District Commission (MDC), the Division of Waterways, the Office of Coastal Zone Management (CZM), and the Massachusetts Environmental Policy Unit (MEPA) of the Commonwealth of Massachusetts are acknowledged for their continuing cooperation in NED activities.

APPENDIX A

HYDROLOGY AND HYDRAULICS

POINT OF PINES
COASTAL FLOOD PROTECTION STUDY
REVERE, MASSACHUSETTS

APPENDIX A
HYDROLOGY AND HYDRAULICS

PREPARED BY
THE
HYDRAULICS AND WATER QUALITY
AND
HYDROLOGIC ENGINEERING SECTIONS
WATER CONTROL BRANCH
AND
COASTAL ENGINEERING
AND
SURVEY SECTION
DESIGN BRANCH
ENGINEERING DIVISION

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS 02254

JUNE 1984

POINT OF PINES
COASTAL FLOOD PROTECTION STUDY
REVERE, MASSACHUSETTS

APPENDIX A
HYDROLOGY AND HYDRAULICS

LIST OF TABLES

POINT OF PINES
COASTAL FLOOD PROTECTION STUDY
REVERE, MASSACHUSETTS

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HYDROLOGY AND HYDRAULICS

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REVERE, MASSACHUSETTS

APPENDIX A
HYDROLOGY AND HYDRAULICS

LIST OF PLATES

POINT OF PINES
COASTAL FLOOD PROTECTION
REVERE, MASSACHUSETTS

APPENDIX A
HYDROLOGY AND HYDRAULICS

INTRODUCTION

A-1. GENERAL

Overtopping of existing walls and sand dune dikes by wind generated waves is the principal agent of coastal flooding in the Point of Pines area of Revere, Massachusetts. Rainfall runoff is a secondary contributing source of interior flooding but of considerable less potential. The amount of wave overtopping is significantly affected by the wave characteristics, local winds, geometry of protective works and ocean level. Substantial variations in water level can be produced by astronomical tides and by storm surges caused by the combination of high onshore winds and low atmospheric pressure. The coincidence of high water level, large waves, and strong onshore winds cause a threat of serious flooding due to wave overtopping. This appendix presents hydrologic and hydraulic information pertinent to flood protection planning for the Point of Pines area of Revere, Massachusetts. Included are sections on: (a) general climatoloty of the area, (b) tidal hydrology of ocean level variations, (c) hydraulics of wave runup and overtopping and the Standard Project Northeaster Tide level, and (e) interior hydrology. A general plan of the Point of Pines area is shown on plate A-1.

During preliminary stage II studies, prior to converting to a detailed project report effort, hydrologic and hydraulic information was provided to planners, for a range of alternative plans of protection, for use in project scoping. Eventual project selection was based on a range of considerations, including, but not limited to, hydrology and hydraulics. Project formulation is discussed in the main report.

As was the case with the neighboring Roughans Point project studies, there are many uncertainties in, and a scarcity of, procedures for precisely quantifying storm wave overtopping and resulting interior flood levels and frequencies at Point of Pines. Physical and numerical tidal model studies for the Revere area are currently underway at the Waterways Experiment Station and should provide more specific information prior to, or during the preparation of any more detailed project plans and specifications for Point of Pines.

CLIMATOLOGY

A-2. GENERAL

Revere, Massachusetts, located at 42 degrees north latitude, has a cool, semi-humid, and most variable climate, typical of New England. Its climate is somewhat less harsh than in the higher inland areas of New England due to the moderating effect of the adjacent ocean waters. Its location on the easterly facing coast of New England exposes the Point of Pines area of Revere to coastal storms that move northeasterly up the Atlantic coast with accompanying intense rainfall, winds and flood producing storm tides and waves.

A-3. TEMPERATURE

The mean annual temperature at Revere is 51° Fahrenheit. Mean monthly temperature varies from a high of 72° in July to 29° Fahrenheit in January and February. Extremes in temperature vary from summertime highs in the nineties to wintertime lows in the minus teens. Mean, maximum and minimum monthly temperatures as recorded over a 109-year period at neighboring Boston are listed in table A-1.

A.4. PRECIPITATION

The mean annual precipitation at Revere is 42 inches based on 110 continuous years of record at neighboring Boston. Precipitation is distributed quite uniformly throughout the year, averaging about 3.5 inches per month. Short duration intense rainfall often results with fast moving frontal systems, thunderstorms, and coastal storms. Also much of the winter precipitation occurs as snowfall. Mean, maximum and minimum monthly precipitation recorded at Boston, Massachusetts is listed in table A-2. Storm rainfalls and frequencies are discussed under Interior Hydrology.

A-5. SNOWFALL

The average annual snowfall at Revere is 43 inches. Mean monthly and annual snowfall recorded at Boston is listed in table A-3. Data on seasonal snowpack is not available for Revere. However, snow surveys by the Corps of Engineers in the Blackstone River basin, about 20 miles south and 15 miles inland from Boston, indicate maximum water equivalent occurs about the 1st of March ranging from near zero to about 6 inches with an average of about 2.7 inches.

TABLE A-1

MONTHLY TEMPERATURE
BOSTON, MASSACHUSETTS
Elevation 15 Feet NGVD
109 Years of Record
(Degrees Fahrenheit)

Month	Mean	Maximum	Minimum
January	29.0	72	-13
February	29.3	68	-11
March	37.7	86	-8
April	47.4	89	11
May	57.9	97	31
June	67.3	100	42
July	72.5	104	46
August	71.6	101	47
September	64.4	102	34
October	54.9	90	25
November	44.5	83	-2
December	32.9	69	-14
Annual	50.8	104	-14

TABLE A-2

MONTHLY PRECIPITATION
BOSTON, MASSACHUSETTS
Elevation 15 Feet NGVD
110 Years of Record
(Inches)

Month	Mean	Maximum	Minimum
January	3.67	10.55	0.35
February	3.35	9.98	0.45
March	3.84	11.75	Trace
April	3.55	10.83	0.20
May	3.24	13.38	0.25
June	3.13	9.13	0.27
July	3.12	12.38	0.52
August	3.64	17.09	0.37
September	3.23	11.95	0.21
October	3.27	8.84	0.06
November	3.80	11.63	0.59
December	3.70	9.74	0.26
Annual	41.54	67.72	23.71

TABLE A-3

MEAN MONTHLY SNOWFALL
BOSTON, MASSACHUSETTS
Elevation 15 Feet NGVD
110 Years of Record
(Average Depth in Inches)

Month	Snowfall
January	11.9
February	12.5
March	7.7
April	1.6
May	T
June	0
July	0
August	0
September	0
October	T
November	1.4
December	8.0
Annual	43.1

TIDAL HYDROLOGY

A-6. ASTRONOMICAL TIDES

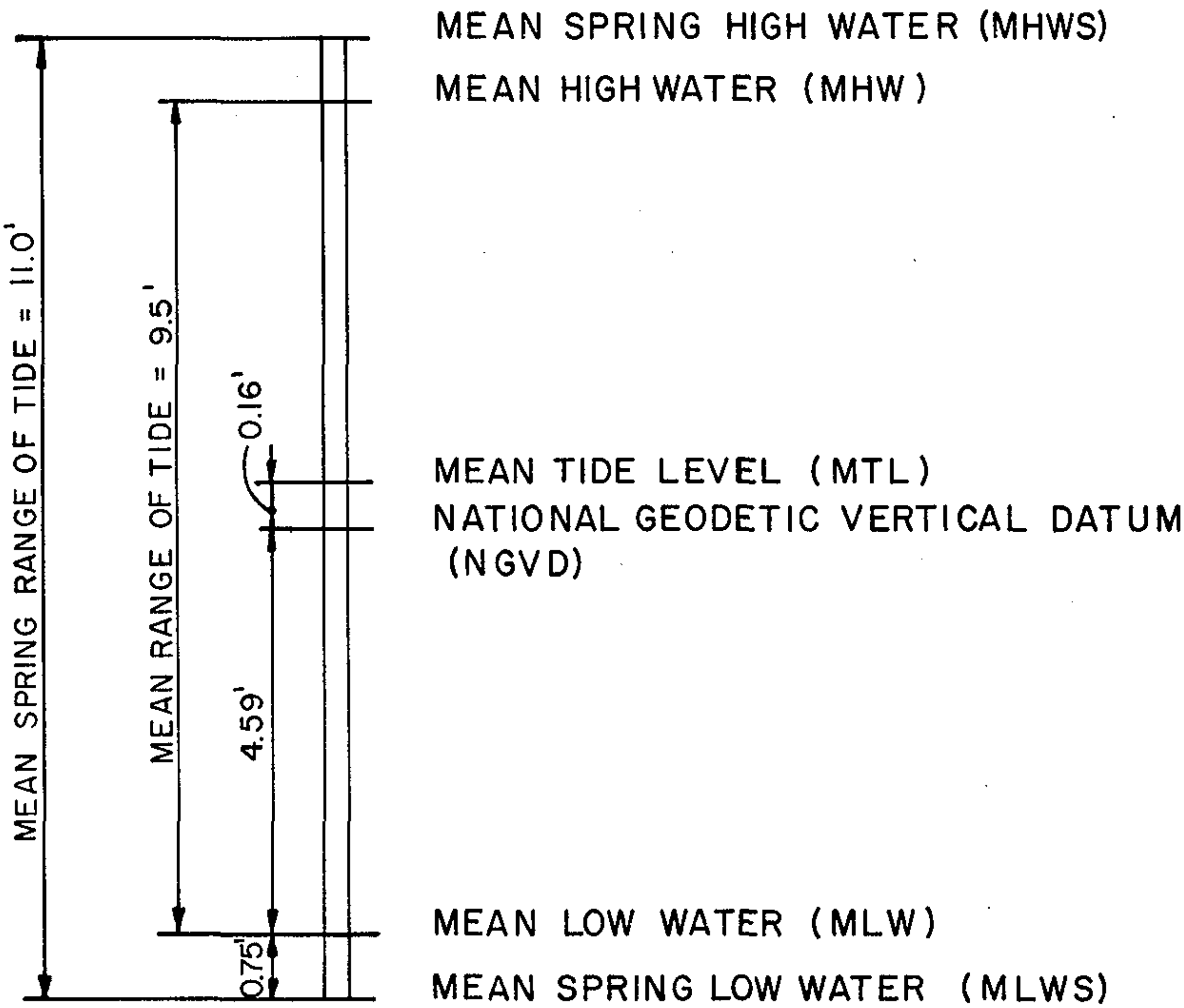
At Revere, tides are semidurnal, with two high and two low waters occurring during each lunar day (approximately 24 hours 50 minutes). The resulting tide range is constantly varying in response to the relative positions of the earth, moon, and sun; the moon having the primary tide producing effect. Maximum tide ranges occur when the orbital cycles of these bodies are in phase. A complete sequence of tide ranges is approximately repeated over an interval of 19 years, which is known as a tidal epoch. At the National Ocean Survey (NOS) tide gage in Boston, Massachusetts (the one nearest to Revere), the mean range of tide and the mean spring range of tide are 9.5 feet and 11.0 feet, respectively (see figure A-1). However, the maximum and minimum probable astronomic tide ranges at Boston have been estimated at about 14.7 and 5.0 feet, respectively, in studies by the Corps Coastal Engineering Research Center (CERC). The variability of astronomical tide ranges is a very significant factor in tidal flooding potential at Revere. This is explained further in section A-9.

Because of the continual variation in water level due to the tides, several reference planes, called tidal datums, have been defined to serve as a reference zero for measuring elevations of both land and water. Tidal datum information for Boston is presented on figure A-1 and table A-4. These data were compiled using currently available NOS tidal benchmark data for Boston along with the CERC report entitled, "Tides and Tidal Datums in the United States," SR No. 7, 1981. The epoch for which the National Ocean Survey has published tidal datum information for Boston is 1941-59. A phenomenon that has been observed through tide gaging and tidal benchmark measurements is that sea level is apparently rising with respect to the land along most of the U.S. coast. At the Boston National Ocean Survey tide gage, the rise has been observed to be slightly less than 0.1 foot per decade. Sea level determination is generally revised at intervals of about 25 years to account for the changing sea level phenomenon. The National Ocean Survey is presently engaged in the process of reducing data from the 1960-1978 tidal datum epoch to make such a revision.

FIGURE A-1

TIDAL DATUM PLANES
BOSTON, MASSACHUSETTS
NATIONAL OCEAN SURVEY TIDE GAGE

(BASED UPON 1941-59 NOS TIDAL EPOCH)



NEW ENGLAND DIVISION
U.S. ARMY, CORPS OF ENGINEERS
WALTHAM, MASS. JUNE 1981

TABLE A-4

BOSTON TIDAL DATUM PLANES
NATIONAL OCEAN SURVEY TIDE GAGE
(BASED UPON 1941-59 NOS TIDAL EPOCH)

	Tide Level (ft., NGVD)
Maximum Probable Astronomic High Water	7.4
Mean Spring High Water (MHWS)	5.7
Mean High Water (MHW)	4.9
Minimum Probable Astronomic High Water	2.6
Mean Tide Level (MTL)	0.2
National Geodetic Vertical Datum (NGVD)	0.0
Maximum Probable Astronomic Low Water	-2.5
Mean Low Water (MLW)	-4.6
Mean Spring Low Water (MLWS)	-5.3
Minimum Probable Astronomic Low Water	-7.2

A comprehensive tide gaging program which will further define the relationship of astronomic tides between Revere and Boston is being initiated under continued planning and engineering studies for the adjacent Roughans Point coastal flood protection project.

A-7. STORM TYPES

Two distinct types of storms, distinguished primarily by their place of origin as being extratropical and tropical cyclones, influence coastal processes in New England. These storms can produce above normal water levels and must be recognized in studying New England coastal problems.

a. Extratropical Cyclones. These are the most frequently occurring variety of cyclones in New England. Low pressure centers frequently form or intensify along the boundary between a cold dry continental air mass and a warm moist marine air mass just off the coast of Georgia or the Carolinas and move northeastward more or less parallel to the coast. These storms derive their energy from the temperature contrast between cold and warm air masses. The organized circulation pattern associated with this type of storm may extend for 1,000 to 1,500 miles from storm center. The wind field in an extratropical cyclone is generally asymmetric with the highest winds in the northeastern quadrant. Since the storm center generally passes parallel and to the southeast of the New England coastline, highest onshore wind speeds are generally from the northeast. For this reason these storms are called "north-easters" or "nor'easters" by New Englanders. As the storm passes, local wind directions may vary from southeast to slightly west of north. Coastlines exposed to these winds can experience high waves and extreme storm surge. Such storms are the principal tidal flood producing events at Revere. The prime season for northeasters in New England is November through April.

b. Tropical Cyclones - These storms form in a warm moist air mass over the Caribbean and the waters adjacent to the West Coast of Africa. The air mass is nearly uniform in all directions from the storm center. The energy for the storm is provided by the latent heat of condensation. When the maximum wind speed in a tropical cyclone exceeds 75 mph, it is labeled a hurricane. Wind velocity at any position can be estimated based upon the distance from the storm center and the forward speed of the storm. The organized wind field may not extend more than 300 to 500 miles from the storm center. Recent hurricanes affecting New England generally have crossed Long Island Sound and proceeded landward in a generally northerly direction. However, hurricane tracks can be erratic. The storms lose much of their strength after landfall. For this reason the southern coast of New England experiences the greatest surge and wave action from the strong southerly to easterly flowing hurricane winds. However, on very rare occasions, reaches of coastline in northern New England may experience some storm surge and wave action from the weakened storm. Hurricanes are not a principle cause of tidal flooding at Revere. The hurricane season in New England generally extends from August through October.

A-8. WINDS

An estimate of wind speed is one of the essential ingredients in determining design wave parameters. The most accurate estimate of winds at sea, which can generate waves and propel them landward, is obtained by utilizing isobars of barometric pressure recorded during a given storm. Wind speed and direction data recorded at land based coastal meteorological stations may not be totally indicative of wind velocities at the sea-air interface far out at sea where the waves are generated.

When estimating wave overtopping of coastal structures, it is necessary to utilize local wind conditions. These local winds help determine how much of the runup from breaking waves is blown over the structures. Examination of wind conditions occurring during past storms is useful when estimating the severity of wave overtopping conditions. Table A-5 presents National Weather Service (NWS) wind observations recorded at Logan Airport in Boston during notable tidal floods. (Owing to Logan Airport being in immediate proximity, wind conditions there are considered to be the same as at Revere). From these data it can be seen that the strongest winds recorded during flood events generally originated from directions between northeast and east. The greatest fastest mile (approximately equal to one-minute average speed) listed, 61 mph from the northeast, was recorded on 6 February 1978 during the great "Blizzard of '78." By comparing table A-5 with table A-8 it can be seen that the stillwater tide levels recorded during these storm events ranged between 10.3 and 8.3 feet NGVD, with recurrence intervals of between 91 and 2 years, respectively. However, extremely severe onshore winds have occurred during storm events which produced significantly lower observed maximum stillwater tide levels in the study area.

Since the astronomic tide range at Revere is so variable, as explained in section A-6, many severe coastal storms occur during periods of relatively low astronomic tides. Thus, even though a storm may produce exceptionally high onshore winds and a tidal surge, the resulting tide level may be less than that occurring during a time of high astronomic tide and no meteorological influence. Table A-6 presents wind data recorded at Logan Airport during storms which produced annual maximum surge values of three feet or more. Comparison with table A-7 shows that the recurrence intervals of the maximum observed tide levels recorded on days of maximum annual storm surge were generally less than one year, with only a few storms producing significant tidal flood levels. Some of the most severe onshore winds and storm surge are shown to have produced minor tidal flooding, owing to their coincidence with low astronomic tides. A good example of this is the 29 November 1945 event which produced the maximum storm surge of record at Boston; extremely high onshore winds occurred during low astronomic tide and resulted in only a minor tidal flood level (7.6 feet NGVD).

Conversely, rather significant tidal flood levels can result from the coincidence of relatively high astronomic tides and only minor meteorological events. Astronomic high tide level in Boston alone can reach 7.4 feet NGVD (see table A-4). With such a condition, a coincident storm surge of only two to three feet could produce major tidal flood levels. The 7 February 1978 storm tide at Boston reached 10.3 feet NGVD, the greatest of record, but was produced by a combination of astronomic tide of 6.9 feet NGVD and surge of 3.4 feet, the latter being of only moderate magnitude (see table A-7).

Wind speed observations recorded by the NWS at Boston's Logan Airport during the great Blizzard of '78 are shown on plate A-8. It shows gusts in excess of 55 knots (63 mph) for about fours from the ENE. Average wind speeds were sustained above 43 knots (49 mph) for nearly four hours from the same direction.

Additionally, Memorandum HUR 8-5 entitled, "Criteria for a Standard Project Northeaster for New England North of Cape Cod" indicates that during maximum storm intensity a Standard Project Northeaster could produce

TABLE A-5

BOSTON - LOGAN INTERNATIONAL AIRPORT
NATIONAL WEATHER SERVICE
WIND OBSERVATIONS RECORDED
DURING NOTABLE TIDAL FLOODS

Date	Resultant Direction	Resultant Speed (mph)	Average Speed (mph)	Fastest Mile Speed (mph)	Fastest Mile Direction
6 Feb 1978	ENE	28.4	29.3	61	NE
29 Dec 1959	NE*	-	20.7	34	E
25 Jan 1979	ENE	23.2	24.2	45	E
19 Feb 1972	NE	21.1	24.2	47	NE
25 May 1967	NE	34.3	34.7	50	NE
21 Apr 1940	-	-	13.3	43**	NE
20 Jan 1961	NNW*	-	26.7	41	NNE
30 Nov 1944	-	-	13.4	48**	NE
9 Jan 1978	SSW	22.8	28.8	43	SW
16 Mar 1976	ENE	15.4	20.4	35	NE
16 Mar 1956	ENE*	-	28.1	54	NE
6 Apr 1958	WSW*	-	13.8	32	SSE
26 Feb 1979	NE	19.1	19.6	30	NE
2 Dec 1974	ENE	15.7	20.7	38	E
7 Mar 1962	NE	-	31.6	42	ENE
4 Apr 1973	E	13.0	13.5	31	E
22 Dec 1972	N	13.3	13.5	21	N

*Resultant speed and direction not available for the period prior to 1964; direction shown is prevailing wind direction.

**Fastest mile not available; value shown in five minute average speed.

NOTE: Listing is in order of decreasing observed stillwater tide level to provide uniformity with table A-8.

TABLE A-6

BOSTON LOGAN INTERNATIONAL AIRPORT
NATIONAL WEATHER SERVICE
WIND OBSERVATIONS RECORDED
DURING ANNUAL MAXIMUM SURGE
PRODUCING STORMS
(1922-1979)

Date	Fastest-Mile Speed (mph)	Fastest-Mile Direction	Average Speed (mph)	Prevailing Direction
29 Nov 1945	63 *	NE	40.5	-
13 Apr 1961	42	ENE	25.0	NE
6 Feb 1978	61	NE	29.3	ENE
14 Feb 1940	51 *	NE	12.7	-
17 Nov 1935	54 *	NE	14.9	-
3 Mar 1947	50 *	E	13.4	-
4 Mar 1960	45	NE	28.0	N
19 Feb 1972	47	NE	24.2	NE
30 Jan 1966	43	S	22.3	SSE
31 Aug 1954	86	SE	31.8	ENE
16 Feb 1958	45	E	28.0	E
12 Nov 1968	54	NE	23.9	E
25 Jan 1979	45	E	24.2	ENE
16 Mar 1956	54	NE	28.1	ENE
22 Mar 1977	60	NE	19.3	E
15 Nov 1962	37	NW	28.5	NW
11 Mar 1924	-	-	-	-
30 Jan 1939	43 *	NE	12.7	-
17 Feb 1952	50	NE	29.8	NE
7 Mar 1923	-	-	-	-
20 Feb 1927	-	-	-	-
19 Jan 1936	40 *	NE	12.6	-
27 Dec 1969	26	E	17.3	WNW
25 Nov 1950	74	E	42.4	E
7 Nov 1953	67	NE	30.5	NE
12 Mar 1959	42	ESE	23.9	SE
16 Apr 1929	-	-	-	-
8 Mar 1931	-	-	-	-
14 Aug 1971	18	E	9.6	E
28 Jan 1973	23	NE	19.4	NE

*Fastest-mile not available; value shown is five-minute average speed.

NOTE: Listing in order of decreasing annual maximum storm surge to allow comparison with Table A-7.

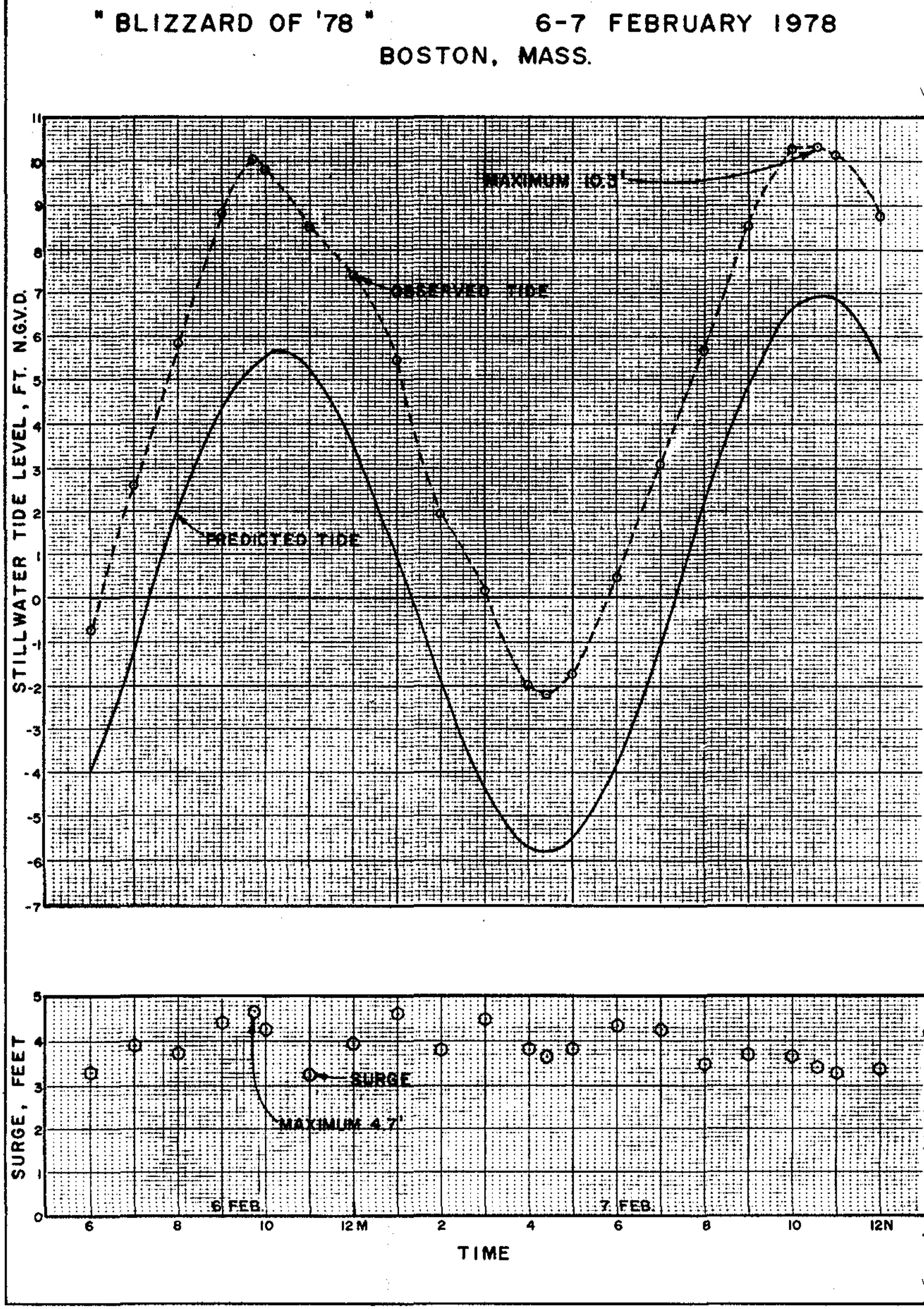
winds approaching 60 knots (69 mph) from the northeast at the project site. Therefore, for design analysis it was assumed that local winds would be about 60 mph from the NE during the period of wave overtopping.

A-9. STORM TIDES AND TIDE STAGE-FREQUENCY

The total effect of astronomical tide combined with storm surge produced by wind, wave, and atmospheric pressure contributions is reflected in actual tide gage measurements. Since the astronomical tide is so variable at the study area, the time of occurrence of the storm surge greatly affects the magnitude of the resulting tidal flood level. Obviously, a storm surge of three feet occurring at a low astronomic tide would not produce as high a water level as would be produced if it occurred at a higher tide. It is important to note that the storm surge itself varies with time thus introducing another variable into the make-up of the total flood tide. The variation in observed tide, predicted tide, and surge at Boston during the "Blizzard of '78" is shown in figure A-2. It is interesting to note that the maximum surge (4.7 feet) occurred just before 10 pm on 6 February. However, the maximum observed tide occurred about 10:30 am the following day when the surge had dropped by 1.3 feet. Had the maximum surge recorded during the storm occurred at 10:30 am on 7 February the observed tide would have been 11.6 feet NGVD, and would have resulted in even more catastrophic flooding at Revere. Annual maximum surge values of greater than or equal to 3.0 feet measured at the Boston, Massachusetts, National Ocean Survey (NOS) tide gage are shown in table A-7. This table shows the importance of coincident astronomic tide in producing significant tidal flooding. (See the discussion in section A-8 which deals with the wind observations recorded during these events.)

The NOS has systematically recorded tide heights at Boston, Massachusetts since 1922. The record prior to that time was developed utilizing staff gage measurements and historical accounts. Maximum observed stillwater tide heights (measurements taken in protected areas in which waves are dampened out) recorded up to 1980 are shown in table A-8. Also shown are the tide heights with an adjustment applied to account for the effect of rising sea level (see section A-6). The greatest observed stillwater tide level recorded occurred during the "Great Blizzard of '78." No hurricanes or tropical storms have produced extreme tide heights at Boston, thus indicating that the principal threat of flooding in the study area is due to storms of the extratropical variety.

A tide stage-frequency relationship for Boston was previously developed utilizing a composite of a Pearson Type III distribution function, with expected probability adjustment, for analysis of historic and systematically observed annual maximum stillwater tide levels and a



" BLIZZARD OF '78 "
6-7 FEBRUARY 1978
BOSTON, MASS.
STILLWATER TIDE LEVEL, FT. N.G.V.D.
MAXIMUM 10.3'
OBSERVED TIDE
PREDICTED TIDE
SURGE, FEET
SURGE
MAXIMUM 4.7'
6 FEB.
7 FEB.
6
8
10
12 M
2
4
6
8
10
12N
TIME

FIGURE A-2

TABLE A-7

ANNUAL MAXIMUM STORM SURGE
BOSTON, MASSACHUSETTS
(1922-1979)

Date	Annual Maximum Storm Surge (feet)	Maximum Observed Tide Level for the Day (ft., NGVD)	Recurrence* Interval (years)
30 Nov 1945	5.1	7.6	LT 1
13 Apr 1961	4.7	8.0	1
6 Feb 1978	4.7	10.0	50
14 Feb 1940	4.4	5.0	LT 1
17 Nov 1935	4.3	6.5	LT 1
3 Mar 1947	4.0	7.2	LT 1
4 Mar 1960	4.0	8.1	2
19 Feb 1972	4.0	9.1	10
30 Jan 1966	3.8	5.5	LT 1
31 Aug 1954	3.7	8.2	2
16 Feb 1958	3.7	7.9	1
12 Nov 1968	3.7	7.7	LT 1
25 Jan 1979	3.7	9.2	13
16 Mar 1956	3.6	5.6	LT 1
22 Mar 1977	3.6	5.3	LT 1
15 Nov 1962	3.5	7.9	1
11 Mar 1924	3.4	6.2	LT 1
31 Jan 1939	3.4	6.9	LT 1
18 Feb 1952	3.4	7.9	1
7 Mar 1923	3.3	6.9	LT 1
20 Feb 1927	3.3	6.9	LT 1
19 Jan 1936	3.3	5.9	LT 1
27 Dec 1969	3.3	6.7	LT 1
25 Nov 1950	3.2	6.4	LT 1
7 Nov 1953	3.2	7.4	LT 1
12 Mar 1959	3.1	6.5	LT 1
16 Apr 1929	3.0	6.6	LT 1
8 Mar 1931	3.0	6.5	LT 1
14 Aug 1971	3.0	5.4	LT 1
29 Jan 1973	3.0	6.1	LT 1

LT = Less Than
*Recurrence interval of observed tide elevations. Obtained from tide stage-frequency relationship, Figure A-3.

TABLE A-8

MAXIMUM STILLWATER TIDE HEIGHTS
BOSTON, MASSACHUSETTS

Date	Observed Elevation (Ft., NGVD)	Adjusted Elevation* (Ft., NGVD)	Recurrence*** Interval (Years)
7 Feb 1978	10.3	10.3	91
16 Apr 1851	10.1	10.4	63
26 Dec 1909	9.9	10.5	42
25 Jan 1979	9.3	9.3	14
29 Dec 1959	9.3	9.5	14
27 Dec 1839	9.2**	—	13
15 Dec 1839	9.2**	—	13
19 Feb 1972	9.1	9.1	11
24 Feb 1723	9.1**	—	11
26 Mar 1830	9.0**	—	9
26 May 1967	8.9	9.0	7
21 Apr 1940	8.9	9.3	7
29 Dec 1853	8.9	9.2	7
4 Dec 1786	8.9**	—	7
20 Jan 1961	8.8	8.9	6
30 Nov 1944	8.8	9.1	6
4 Mar 1931	8.8	9.2	6
3 Dec 1854	8.8	9.1	6
3 Nov 1861	8.7	9.1	5
9 Jan 1978	8.6	8.6	4
16 Mar 1976	8.6	8.6	4
17 Mar 1956	8.6	8.8	4
7 Apr 1958	8.5	8.7	4
15 Nov 1871	8.5	9.0	4
23 Nov 1858	8.5	8.9	4
26 Feb 1979	8.4	8.4	3
2 Dec 1974	8.4	8.4	3
7 Mar 1962	8.4	8.5	3
4 Apr 1973	8.3	8.3	2
22 Dec 1972	8.3	8.3	2
28 Jan 1933	8.3	8.7	2
31 Dec 1857	8.3	8.7	2

*Observed values after adjustment for changing mean sea level; adjustment made to 1975 mean sea level.

**Approximate value based upon historical account. Record not sufficient to document change of sea level for this time.

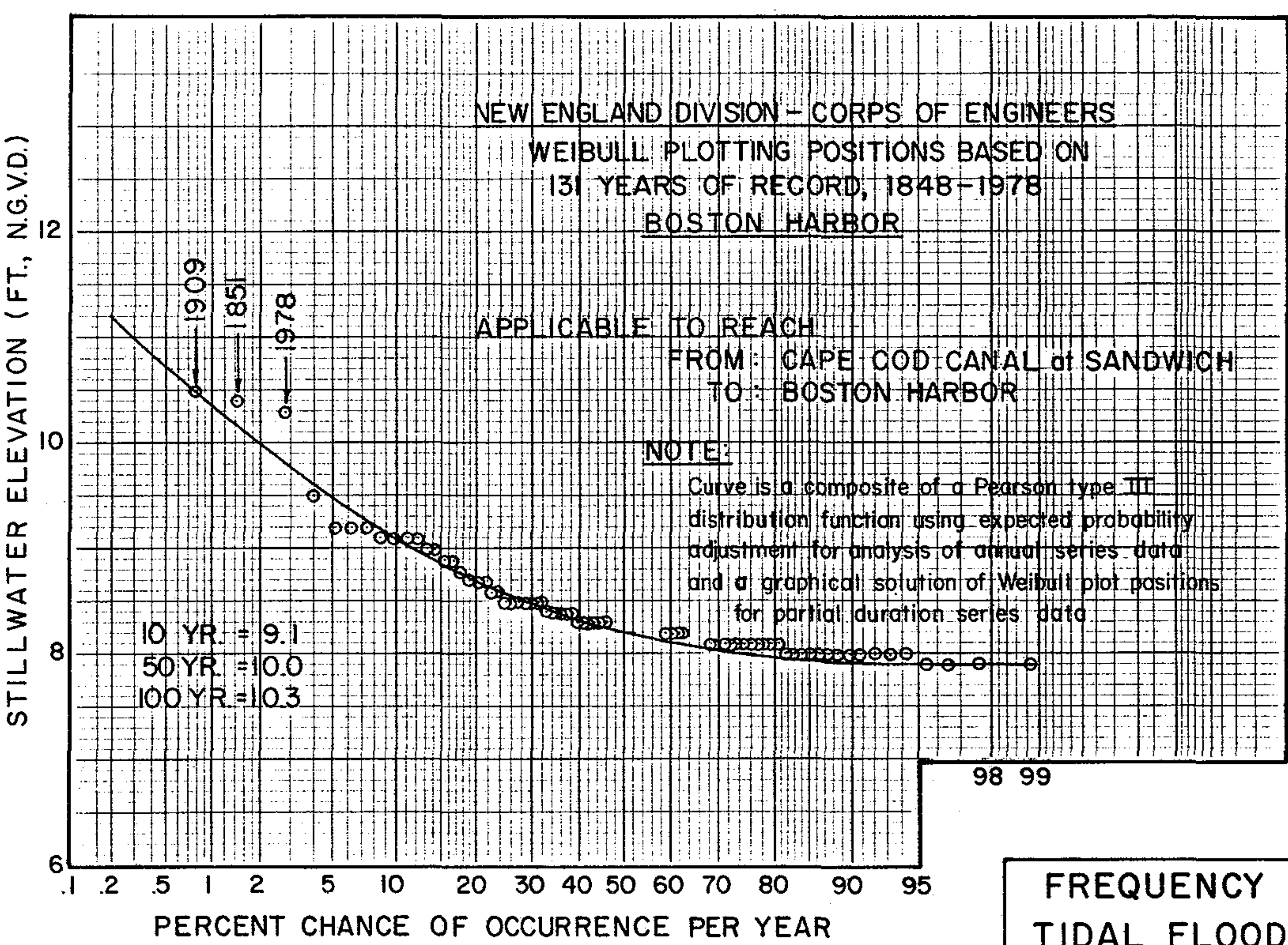
***Recurrence interval of observed tide elevations. Obtained from tide stage-frequency relationship, Figure A-3.

NOTE: Events occurring within about 30 days of a greater tide producing event are exluded from this list. Events recorded during years for which only partial records are available were also excluded.

graphical solution of Weibull plot positions for partial duration series data. The resulting tide stage-frequency curve is shown on figure A-3.

NOS tide gage records and high watermark data gathered after major storms have been utilized in the development of profiles of tidal floods along the New England coast. Additionally, profiles of storm tides for selected recurrence intervals have been developed utilizing tide stage-frequency curves and high watermark information. A location map and profile for the reach of the New England coast bounding Revere are shown on figures A-4 and A-5, respectively.

A comprehensive tide gaging program and hydrodynamic modelling effort being conducted in continued planning and engineering studies for the adjacent Roughans Point investigation will provide additional information on storm tide-frequency relationships at Point of Pines.



FREQUENCY OF TIDAL FLOODING AT BOSTON HARBOR

AUG. 1979

WITH 1 OUTLIER

FIGURE A-3

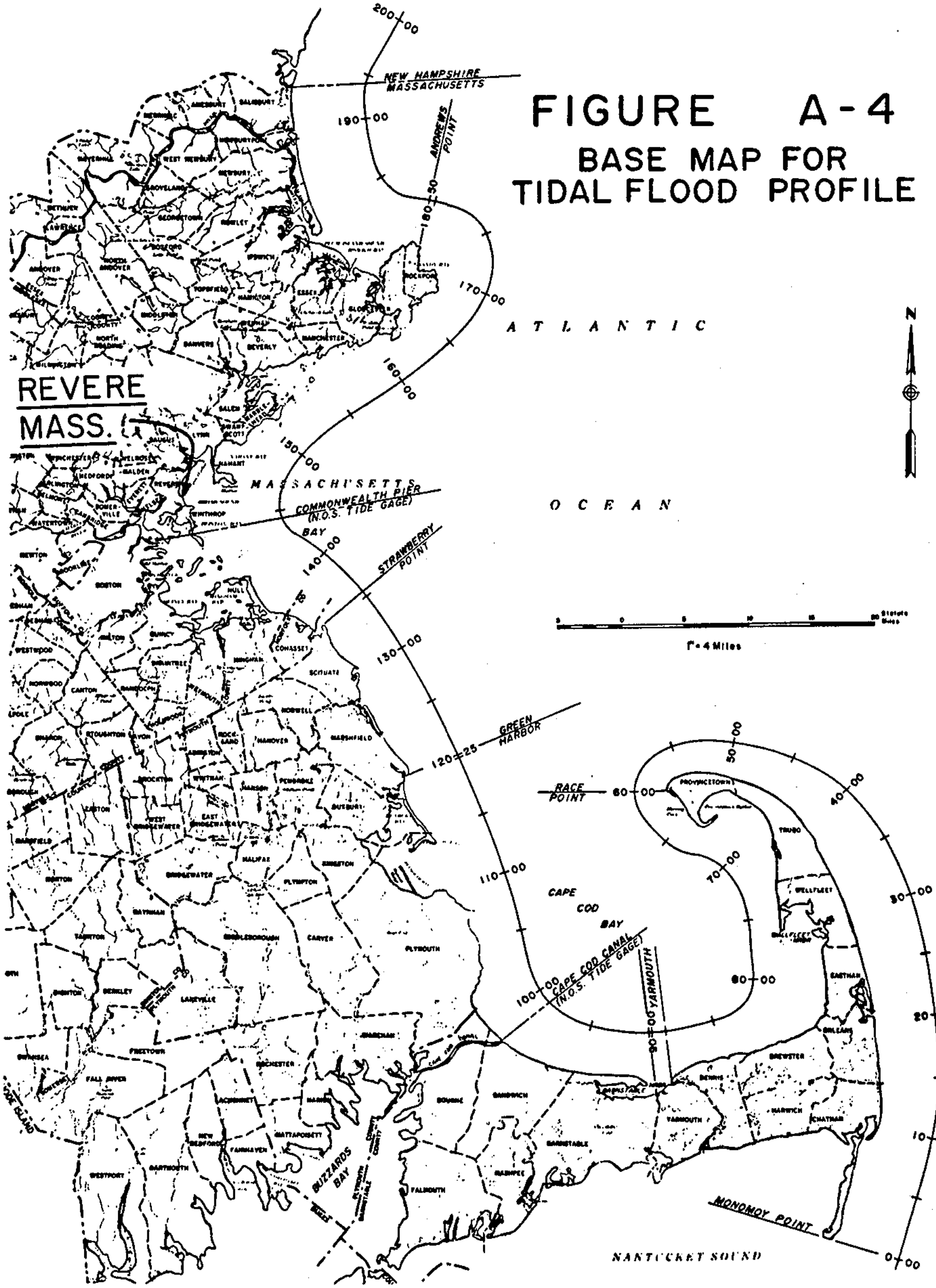
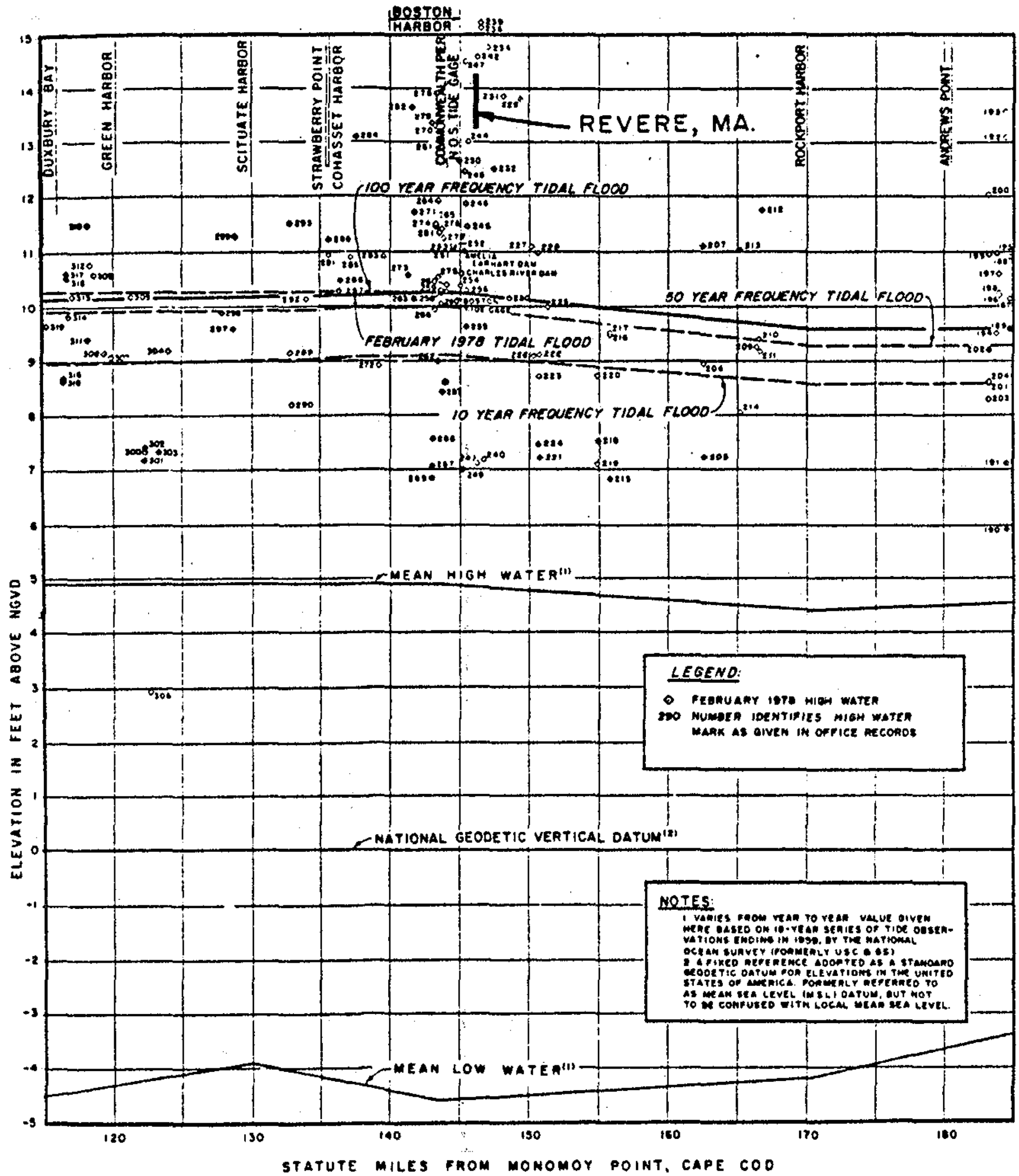


FIGURE A-4
BASE MAP FOR TIDAL FLOOD PROFILE

FIGURE A-5

TIDAL FLOOD PROFILE



5 0 5 10 15 20 STATUTE MILES

HYDRAULICS

A-10. STANDARD PROJECT NORTHEASTER (SPN) TIDE LEVEL

As this is one of the first studies of coastal flood protection along the east coast of New England by the New England Division, Corps of Engineers, a SPN storm tide has not previosuly been developed. The U.S. Army Waterways Experiment Station (WES) will be determining a SPN tide level for Revere in hydrodynamic modelling efforts for the adjacent Roughans Point study. However, the results of these studies will not be available until about January 1985.

The prospect of delaying the detailed project report (DPR) while the SPN tide level was developed was considered unreasonable. With prior approval from the Office of the Chief of Engineers, NED proceeded through the DPR using an approximation of the SPN, determined as follows:

(1) The complete record (1922-present) of the NOS tide gage at Boston Harbor was analyzed to determine the maximum recorded storm surge (observed level minus predicted astronomic level). Previous analysis of the record up to 1960 only, performed by the USWB and shown in USWB Memorandum HUR 8-5, yielded a maximum surge of 5.1 feet. The Techniques Development Laboratory of the NWS, as a part of their studies of Boston tide data, updated this record to 1979 for NED and found that the 5.1-foot value remained as the maximum surge of record. By comparison, this surge value is only 0.4 feet higher than that experienced during the "Blizzard of '78."

(2) The maximum surge of record was then added to the maximum probable astronomic tide which was obtained from the CERC report entitled: "Tides and Tidal Datums in the United States." As a comparison, the maximum probable astronomic tide is only 0.5 feet higher than the maximum astronomic tide which occurred during the 1978 storm event.

	Feet
Surge, Maximum Observed (30 Nov 1945)	5.1
Maximum Probable Astronomic Tide (NGVD)	7.4
Estimated SPN Stillwater Tide Level (NGVD)	12.5, say 13 feet

An SPN stillwater tide level of 13 feet was adopted for use in this planning investigation. Such an estimate appears reasonable when compared to the 6-7 February 1978 storm tide level of 10.3 feet NGVD, which is the greatest observed tide in Boston and which has a 1.0 percent chance of occurrence (100-year recurrence interval) annually. (See figure A-3).

Results of the more formal analysis being conducted by WES for development of the SPN tide level at Revere will be available for use in the preparation of plans and specifications in the event the project is approved for construction.

Concurrence in the above approach to the tidal hydrology aspect of the study and approval to proceed on that basis was received by letter from OCE in May 1983. (Ref. DAEN-ECE-B, 10 May 1983, 1st Ind, Hydrologic Criteria - Revere, Massachusetts Coastal Flood Protection).

A-11. WAVE HEIGHT AND RUNUP

a. Design Wave Height. A design significant wave height of 9.0 ft. was derived from deep water wave curves from the Shore Protection Manual of 1977. This was based on:

(1) Storms entering from the east-northeast, clockwise, through the southeast with an unlimited fetch: and

(2) Sustained wind speeds of 60 miles per hour (mph) from the same direction for a duration of 1-1/2 hours.

b. Existing Conditions. Wave runup calculations were performed for various stillwater levels along profile lines 1 through 9, for non-breaking waves, breaking waves at the toe of the structure, and breaking waves on the fronting beach slope. Table A-9a presents a summary of the critical conditions for each profile.

c. Improvements to Existing Conditions. Wave runup calculations were performed for various stillwater levels along profile lines 2 through 9, for non-breaking waves, breaking waves at the toe of the structure, and breaking waves on the fronting beach slope. Revetments with slopes 1 vertical on 2 horizontal and 1 vertical on 3 horizontal were evaluated. Tables A-9b and A-9c are summaries of the critical conditions for each profile.

TABLE A-9a

WAVE RUNUP ANALYSIS
EXISTING CONDITIONS

PROFILE LINE	LINEAR FEET REPRESENTED	STILL WATER LEVEL FT (NGVD)	SLOPE OF PROTECTION	SIGNIFICANT WAVE HEIGHT (H_s) FT	BREAKING WAVE HEIGHT (H_b) FT	TOP EL. OF RUNUP FT (NGVD)
1	210'	9.0'	1 on 0.9*	6.4'	7.9'	24.0'
1	210'	10.3'	1 on 0.7*	7.9'	9.2'	29.9'
1	210'	11.2'	1 on 0.6*	8.9'	10.2'	33.1'
1	210'	13.0'	1 on 0.6*	9.0'	10.4'	35.3'
3	440'	6.0'	1 on 2.4/1 on 25	3.4'	4.8'	12.0'
3	440'	8.0'	1 on 2.4/1 on 25	5.4'	6.8'	16.1'
3	440'	9.0'	1 on 2.4/1 on 25	6.4'	7.8'	17.9'
3	440'	10.3'	1 on 2.4/1 on 25	7.5'	8.9'	19.6'
3	440'	11.2'	1 on 2.4/1 on 25	8.2'	9.7'	21.1'
3	440'	13.0'	1 on 2.4/1 on 25	9.0'	10.4'	23.0'
4	460'	10.3'	1 on 2.8/1 on 14	4.6'	6.5'	16.7'
4	460'	11.2'	1 on 0.8*	---	5.7'	27.7'
4	460'	13.0'	1 on 0.6*	7.5'	9.4'	35.5'
5	420'	10.3'	1 on 10.2	9.0'	10.4'	14.7'
5	420'	10.8'	1 on 6.3*	9.0'	10.4'	18.0'
5	420'	11.2'	1 on 6.2*	9.0'	10.4'	18.2'
5	420'	13.0'	1 on 4.1*	9.0'	10.4'	24.0'
6	320'	10.3'	1 on 16	9.0'	10.4'	13.4'
6	320'	11.2'	1 on 16	9.0'	10.4'	14.3'
6	320'	11.8'	1 on 13.3*	9.0'	10.4'	15.1'
6	320'	12.5'	1 on 12.9*	9.0'	10.4'	15.8'
6	320'	13.0'	1 on 12.2*	9.0'	10.4'	16.6'
7	350'	10.3'	1 on 16	9.0'	10.4'	13.4'
7	350'	11.2'	1 on 16	9.0'	10.4'	14.3'
7	350'	11.8'	1 on 13.2*	9.0'	10.4'	15.1'
7	350'	12.5'	1 on 12.4*	9.0'	10.4'	16.1'
7	350'	13.0'	1 on 4.3/1 on 16	1.15'	2.3'	17.5'

* Composite Slope Design

TABLE A-9a

WAVE RUNUP ANALYSIS
EXISTING CONDITIONS

PROFILE LINE	LINEAR FEET REPRESENTED	STILL WATER LEVEL FT(NGVD)	SLOPE OF PROTECTION	SIGNIFICANT WAVE HEIGHT (H_s) FT	BREAKING WAVE HEIGHT (H_b) FT	TOP EL. OF RUNUP FT (NGVD)
8	500'	10.3'	1 on 15.2*	9.0'	10.4'	13.1'
8	500'	11.2'	1 on 14.0*	9.0'	10.4'	14.4'
8	500'	12.0'	1 on 13.4*	9.0'	10.4'	15.0'
8	500'	13.0'	1 on 5/1 on 18	2.6'	4.1'	18.9'
9	600'	10.3'	1 on 18.1'	9.0'	10.4'	12.9'
9	600'	11.2'	1 on 15.9'	9.0'	10.4'	14.0'
9	600'	13.0'	1 on 12.7'	9.0'	10.4'	16.5'

* Composite Slope Design

TABLE A-9b

WAVE RUNUP ANALYSIS-ROCK REVETMENT WITH A SLOPE OF 1 VERTICAL ON 2 HORIZONTAL

PROFILE LINE	LINEAR FEET REPRESENTED	STILL WATER LEVEL FT (NGVD)	SLOPE OF PROTECTION	SIGNIFICANT WAVE HEIGHT (H_s) FT	BREAKING WAVE HEIGHT (H_b) FT	TOP EL. OF RUNUP FT (NGVD)	BREAKING POINT OF WAVE
2	200'	10.3'	1 on 2/ 1 on 20	8.8'	10.3'	21.2'	Toe of Structure
2	200'	11.2'	1 on 2/ 1 on 20	9.0'	10.4'	22.4'	" " "
2	200'	13.0'	1 on 2/ 1 on 20	9.0'	10.4'	24.3'	" " "
3	440'	10.3'	1 on 2/ 1 on 25	9.0'	10.4'	21.6'	" " "
3	440'	11.2'	1 on 2/ 1 on 25	9.0'	10.4'	22.6'	" " "
3	440'	13.0'	1 on 2/ 1 on 25	9.0'	10.4'	24.5'	" " "
4	460'	10.3'	1 on 2/ 1 on 14	7.8'	9.7'	21.0'	" " "
4	460'	11.2'	1 on 2/ 1 on 14	8.7'	10.4'	21.9'	" " "
4	460'	13.0'	1 on 2/ 1 on 14	9.0'	10.4'	24.5'	" " "
5&6	740'	10.3'	1 on 9.3*	9.0'	10.4'	15.0'	Seaward of Structure
5&6	740'	11.2'	1 on 2/ 1 on 14	2.1'	3.5'	16.3'	Toe of Structure
5&6	740'	13.0'	1 on 2/ 1 on 14	4.2'	6.0'	20.5'	Toe of Structure
7&8	850'	10.3'	1 on 9.3*	9.0'	10.4'	15.0'	Seaward of Structure
7&8	850'	11.2'	1 on 2/ 1 on 14	2.1'	3.5'	16.3'	Toe of Structure
7&8	850'	13.0'	1 on 2/ 1 on 14	4.2'	6.0'	20.5'	" " "
9	600'	10.3'	1 on 2/ 1 on 50	0.2'	0.3'	10.7'	" " "
9	600'	11.2'	1 on 2/ 1 on 50	0.5'	1.2'	12.2'	" " "
9	600'	13.0'	1 on 2/ 1 on 50	2.0'	2.9'	17.3'	" " "

*Composite Slope Design

TABLE A-9C

WAVE RUNUP ANALYSIS-ROCK REVETMENT WITH A SLOPE OF 1 VERTICAL ON 3 HORIZONTAL

PROFILE LINE	LINEAR FEET REPRESENTED	STILL WATER LEVEL FT (NGVD)	SLOPE OF PROTECTION	SIGNIFICANT WAVE HEIGHT FT (H_s)	BREAKING WAVE HEIGHT (H_b) FT	TOP EL. OF RUNUP FT (NGVD)	BREAKING POINT OF WAVE
2	200'	10.3'	1 on3/1 on 20	9.0'	10.4'	18.5'	Toe of Structure
2	200'	11.2'	1 on3/1 on 20	9.0'	10.4'	19.4'	" " "
2	200'	13.0'	1 on3/1 on 20	9.0'	10.4'	21.3'	" " "
3	440'	10.3'	1 on3/1 on 25	9.0'	10.4'	18.6'	" " "
3	440'	11.2'	1 on3/1 on 25	9.0'	10.4'	22.2'	" " "
3	440'	13.0'	1 on3/1 on 25	9.0'	10.4'	24.2'	" " "
4	460'	10.3'	1 on3/1 on 30	8.2'	9.3'	18.3'	" " "
4	460'	11.2'	1 on3/1 on 30	8.8'	9.9'	19.4'	" " "
4	460'	13.0'	1 on3/1 on 30	9.0'	10.4'	21.3'	" " "
5&6	740'	10.3'	1 on 9.3*	9.0'	10.4'	14.6'	Seaward of Structure
5&6	740'	11.2'	1 on3/1 on 14	3.3'	4.9'	16.2'	Toe of Structure
5&6	740'	13.0'	1 on3/1 on 14	5.4'	7.2'	19.6'	" " "
7&8	850'	10.3'	1 on 9.3*	9.0'	10.4'	14.6'	Seaward of Structure
7&8	850'	11.2'	1 on3/1 on 14	3.3'	4.9'	16.2'	Toe of Structure
7&8	850'	13.0'	1 on3/1 on 14	5.4'	7.2'	19.6'	" " "
9	600'	10.3'	1 on3/1 on 50	0.2'	0.3'	10.6'	" " "
9	600'	11.2'	1 on3/1 on 50	0.5'	1.2'	12.3'	" " "
9	600'	13.0'	1 on3/1 on 50	2.0'	2.9'	16.9'	" " "

* Composite Slope Design

A-12. DESIGN WAVE OVERTOPPING

Estimates of wave overtopping have been computed for existing and alternative methods of protection for Point of Pines (descriptions of the protection types are provided in the main report). A local wind speed of about 60 mph from the northeast was assumed to be occurring during the period of wave overtopping. (A significant number of alternatives were examined during stage II planning studies prior to initiation of work under Section 205 authority. These were dismissed for a variety of reasons. Descriptions are included in the main report).

Utilizing the methodology presented in sections 7.221 and 7.222 of the 1977 edition of the Shore Protection Manual average rates of irregular wave overtopping were computed for various stillwater tide levels, thus allowing for the development of rating curves of tide level versus overtopping rate. Tide stage hydrographs having selected maximum stillwater tide heights were then developed by appropriate adjustment of the tide hydrograph observed 7 February 1978 during the great northeaster of 6-7 February 1978. Combining this information, wave overtopping hydrographs for these tidal floods were then developed for use in interior flooding studies. Hydrographs developed for the existing condition and the alternative plans are shown in figures A-6 and A-7. Average rates of irregular wave overtopping in reaches B through E at various tide levels for existing conditions, as well as for the alternative plans studied, are shown in table A-10. Existing and modified wave overtopping hydrographs were computed separately for structural protection at reaches B, C, and D for sand dune protection in reach E. Along the Pines River (reaches F and G) flooding is due primarily to the stillwater tide (STL) and not wave action. In reach G, flooding due to the STL begins at 8.5 feet NGVD for the existing conditions.

It should be noted that ongoing physical and mathematical model studies being conducted in Roughans Point CP&E studies will yield results which will allow for refinements to the wave overtopping analysis for Point of Pines in the preparation of plans and specifications.

TABLE A-10a

WAVE OVERTOPPING RATES
REACHES B, C, & D - STRUCTURAL PROTECTION
POINT OF PINES
REVERE, MASSACHUSETTS

Stillwater Tide Level (Ft., NGVD)	Existing Conditions*	Estimated Average Rate of Irregular Wave Overtopping in CFS: Minimum Top of Wall Level: 15.0 feet, NGVD; Front Slope: 1 on 3	Minimum Top of Wall Level: 16.5 feet, NGVD; Front Slope: 1 on 3	Minimum Top of Wall Level: 18.3 feet, NGVD; Front Slope: 1 on 3
13.0	8,050	3,650	2,400	725
12.0	4,000	1,925	1,250	390
11.2	2,000	1,050	660	160
10.3	425	425	280	**
9.0	140	60	**	**
8.0	40	**	**	**
7.0	**	**	**	**

* Wave overtopping for existing conditions was determined using composite slope analysis. A lower degree of confidence is associated with the estimates of existing overtopping than the proposed. Therefore, comparisons between existing and proposed overtopping can only serve as a rough guide.

** No substantial wave overtopping expected.

TABLE - A-10b

WAVE OVERTOPPING RATES
SAND DUNE PROTECTION - REACH E
POINT OF PINES
REVERE, MASSACHUSETTS

Stillwater Tide Level (Ft., NGVD)	Estimated Average Rate of Irregular Wave Overtopping in CFS: Existing Conditions	Estimated Average Rate of Irregular Wave Overtopping in CFS: Minimum Top of Dune Level 14.3 feet, NGVD
13.0	*	2,390
12.0	4,350	960
11.2	1,500	160
10.3	120	**
9.0	**	**

*Section with a top elevation of 12.5 feet, NGVD, is overtopped by the stillwater tide level, therefore, wave overtopping rate was not computed.

**No substantial wave overtopping expected.

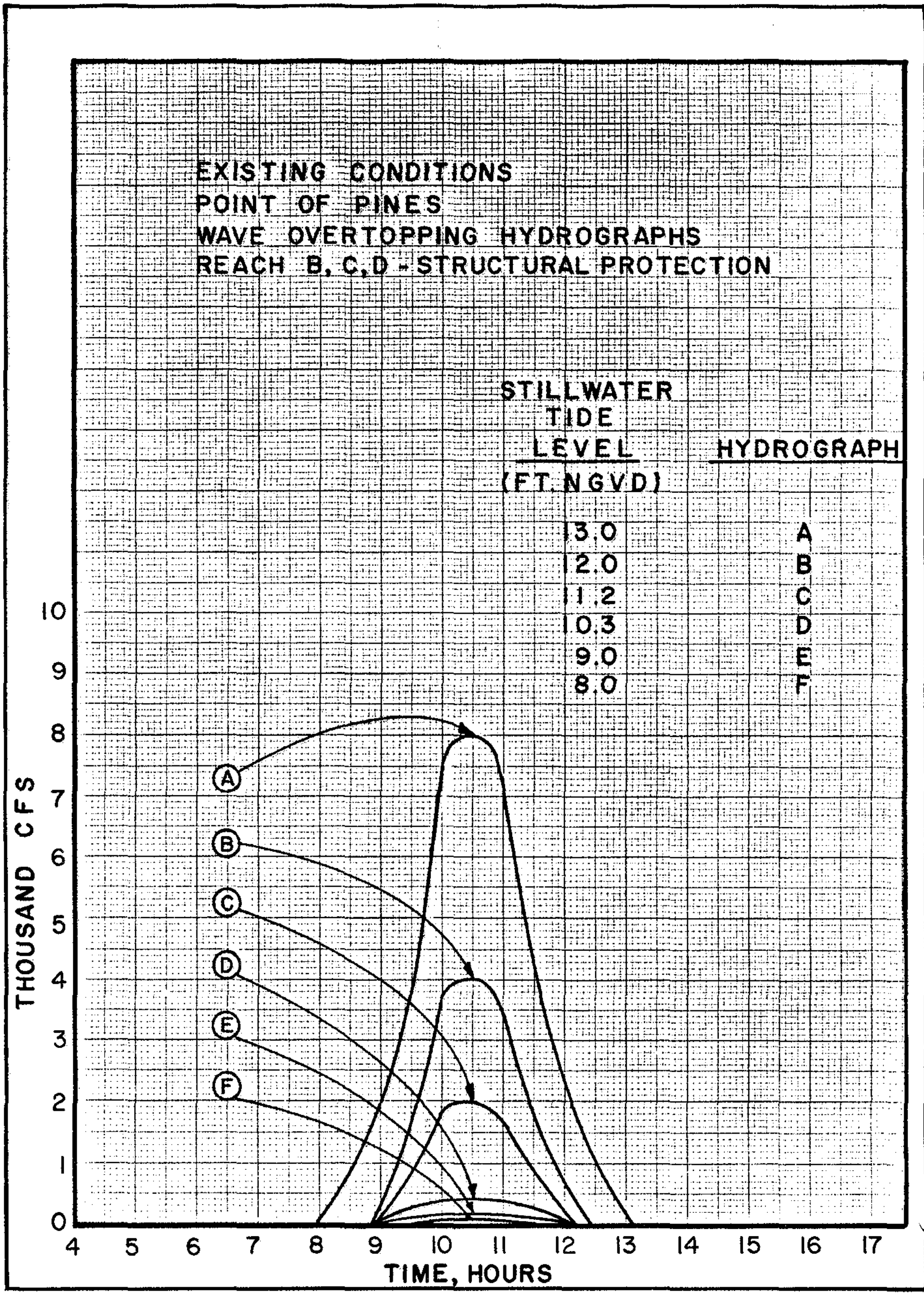

EXISTING CONDITIONS
POINT OF PINES
WAVE OVERTOPPING HYDROGRAPHS
REACH B, C, D - STRUCTURAL PROTECTION
STILLWATER TIDE LEVEL (FT. NGVD)
HYDROGRAPH
13.0 A
12.0 B
11.2 C
10.3 D
9.0 E
8.0 F
A
B
C
D
E
F
THOUSAND CFS
0
1
2
3
4
5
6
7
8
9
10
TIME, HOURS
4
5
6
7
8
9
10
11
12
13
14
15
16
17

FIGURE A-6A

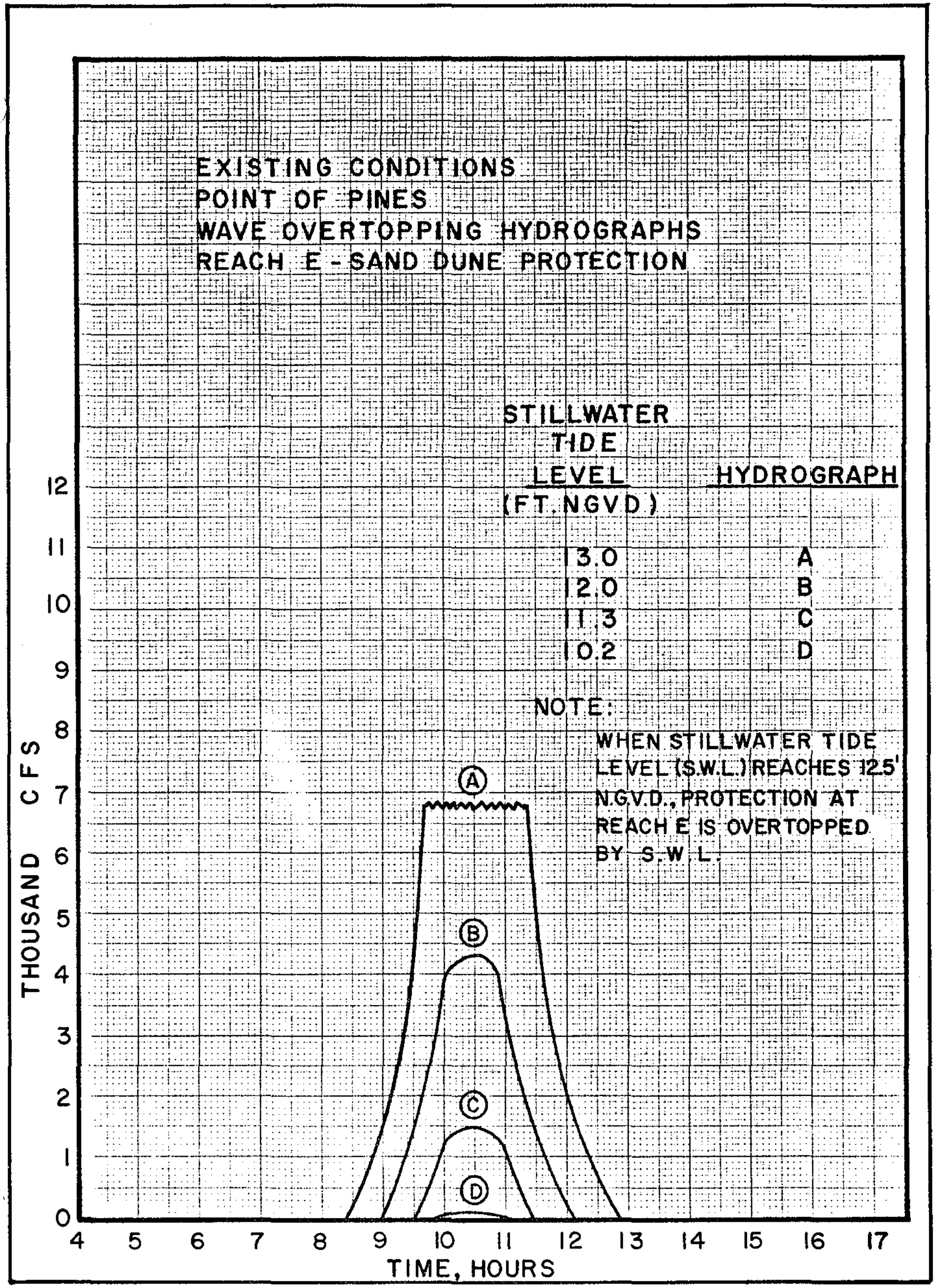

EXISTING CONDITIONS
POINT OF PINES
WAVE OVERTOPPING HYDROGRAPHS
REACH E - SAND DUNE PROTECTION
STILLWATER TIDE LEVEL (FT. NGVD)
HYDROGRAPH
13.0 A
12.0 B
11.3 C
10.2 D
NOTE:
WHEN STILLWATER TIDE LEVEL (S.W.L.) REACHES 12.5' N.G.V.D., PROTECTION AT REACH E IS OVERTOPPED BY S.W.L.
A
B
C
D
THOUSAND CFS
0
1
2
3
4
5
6
7
8
9
10
11
12
4
5
6
7
8
9
10
11
12
13
14
15
16
17
TIME, HOURS

FIGURE A-6B

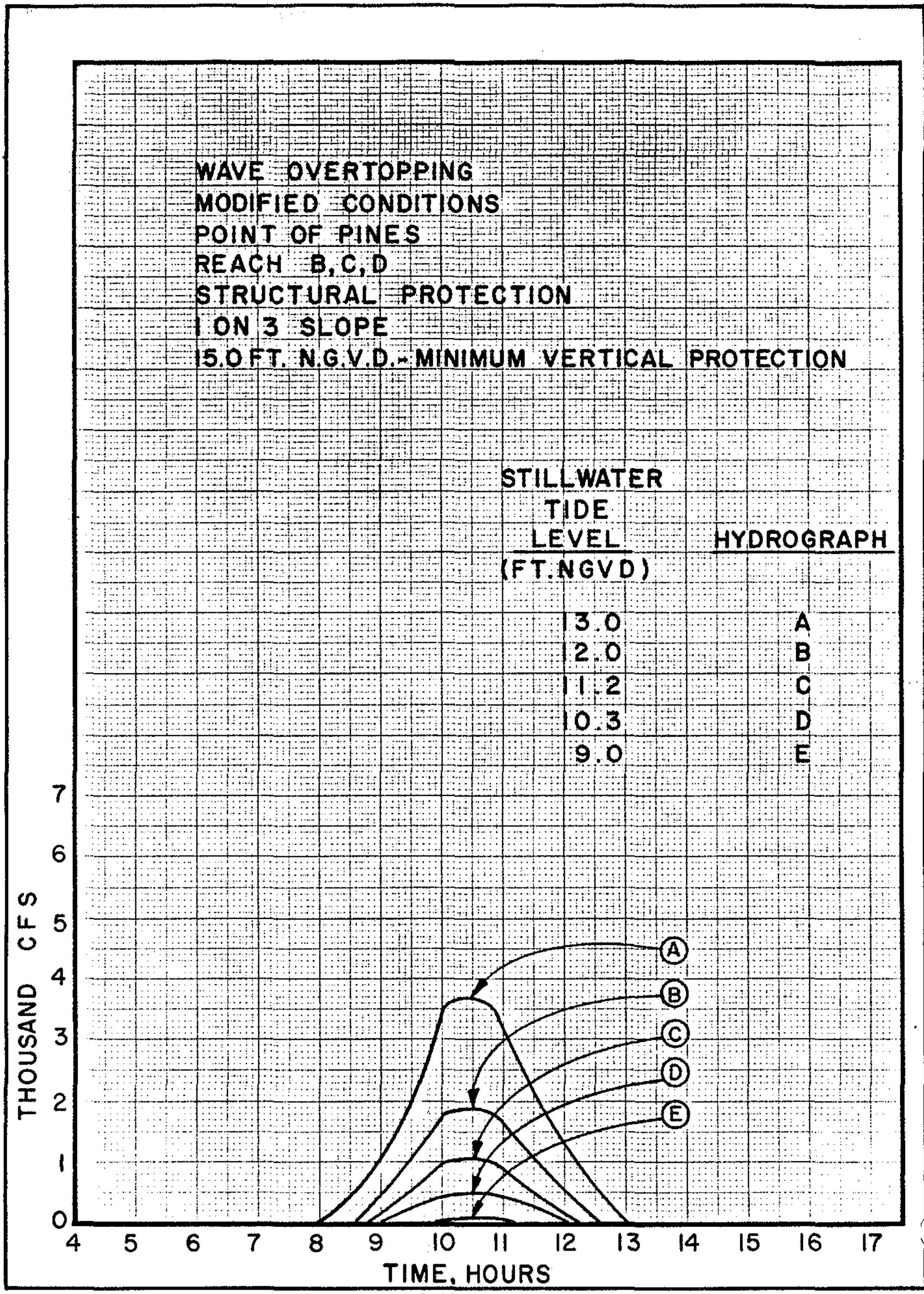
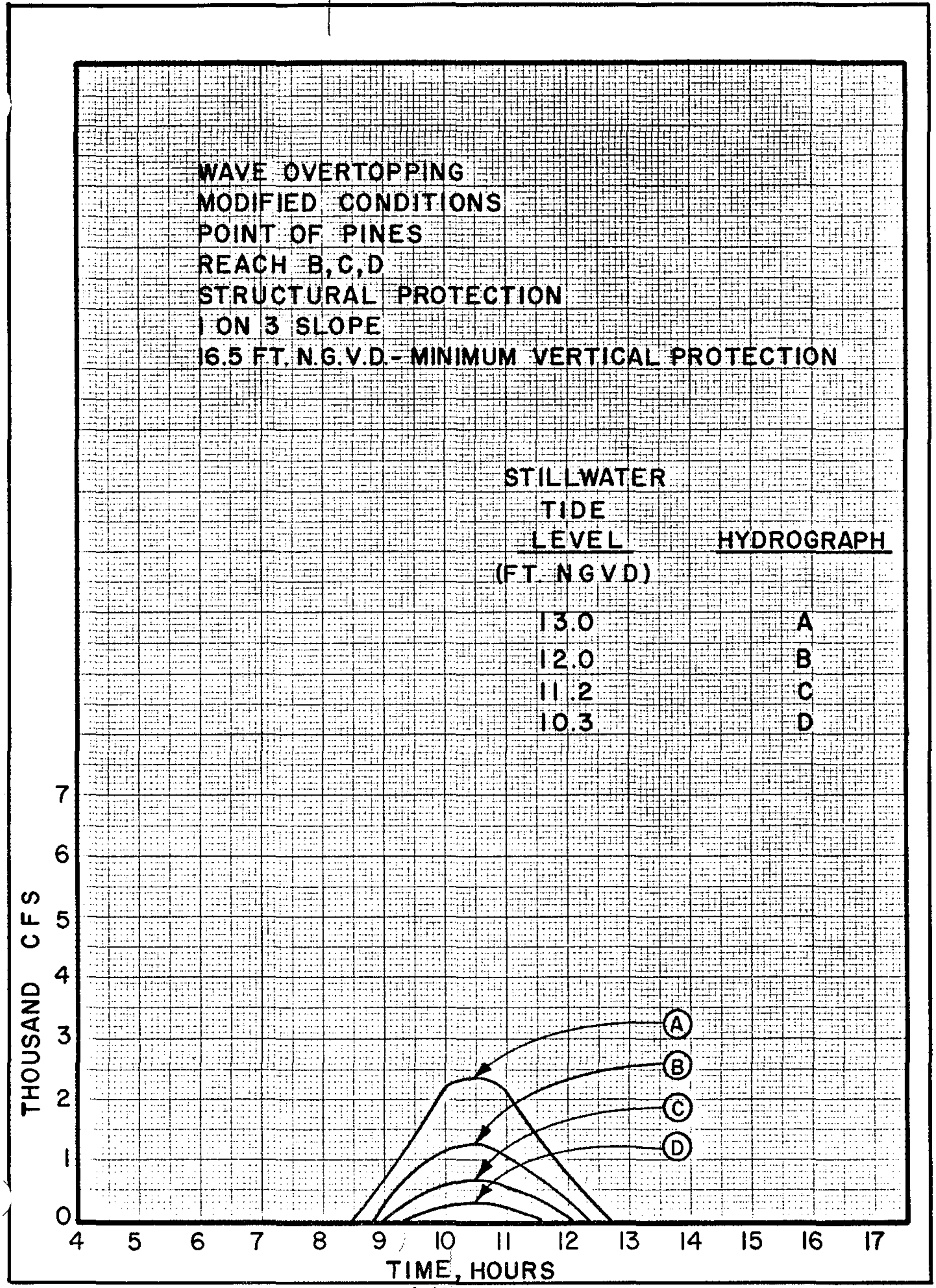

WAVE OVERTOPPING
MODIFIED CONDITIONS
POINT OF PINES
REACH B, C, D
STRUCTURAL PROTECTION
1 ON 3 SLOPE
15.0 FT. N.G.V.D.- MINIMUM VERTICAL PROTECTION
STILLWATER TIDE LEVEL (FT. NGVD)
HYDROGRAPH
13.0 A
12.0 B
11.2 C
10.3 D
9.0 E
THOUSAND CFS
0
1
2
3
4
5
6
7
TIME, HOURS
4 5 6 7 8 9 10 11 12 13 14 15 16 17
A
B
C
D
E

FIGURE A-7A



WAVE OVERTOPPING
MODIFIED CONDITIONS
POINT OF PINES
REACH B,C,D
STRUCTURAL PROTECTION
1 ON 3 SLOPE
16.5 FT. N.G.V.D.- MINIMUM VERTICAL PROTECTION
STILLWATER TIDE LEVEL (FT. NGVD)
HYDROGRAPH
13.0 A
12.0 B
11.2 C
10.3 D
THOUSAND CFS
0
1
2
3
4
5
6
7
4 5 6 7 8 9 10 11 12 13 14 15 16 17
TIME, HOURS
A
B
C
D

FIGURE A-7B

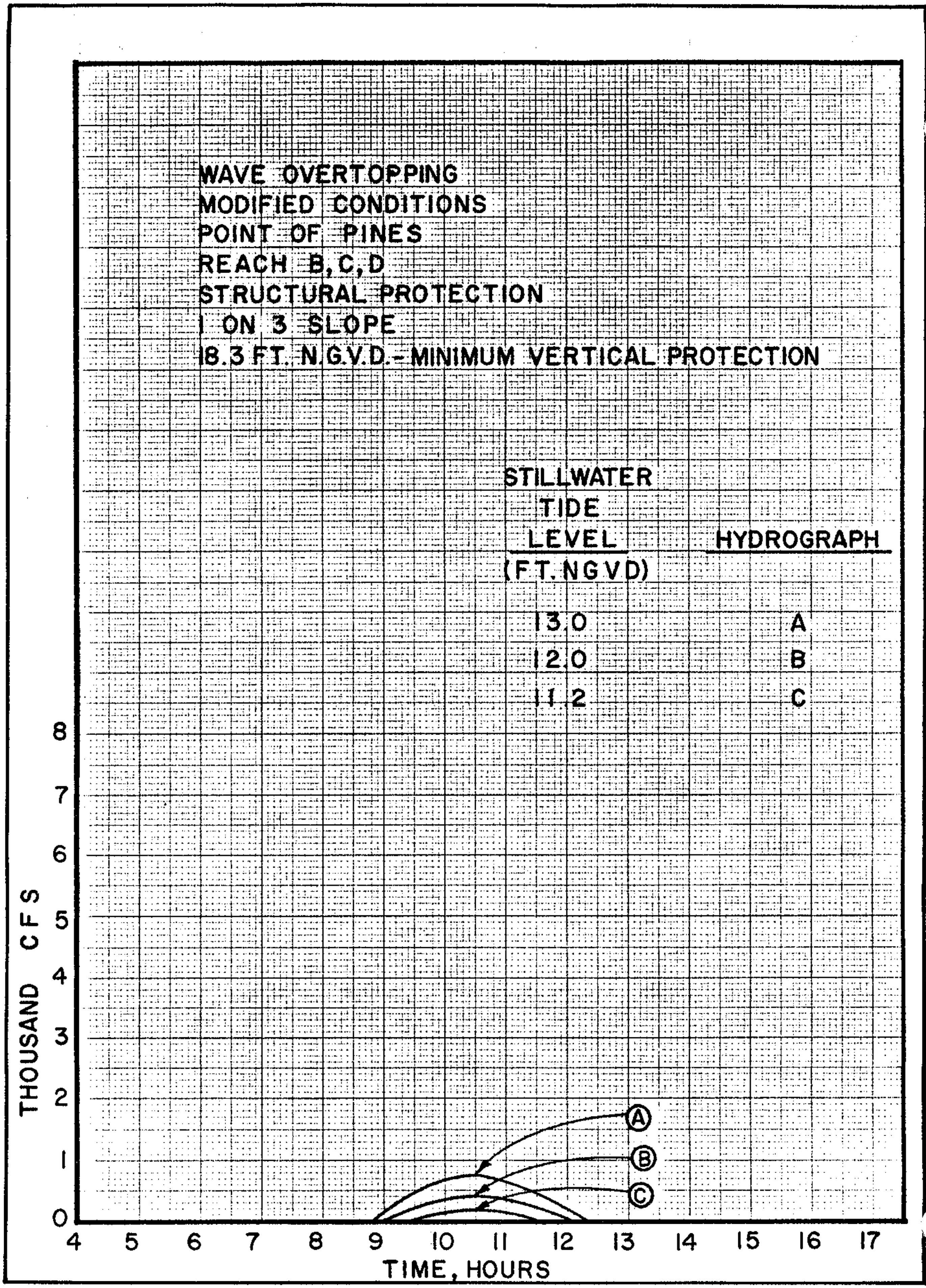

WAVE OVERTOPPING
MODIFIED CONDITIONS
POINT OF PINES
REACH B, C, D
STRUCTURAL PROTECTION
1 ON 3 SLOPE
18.3 FT. N.G.V.D. - MINIMUM VERTICAL PROTECTION
STILLWATER TIDE LEVEL (FT. NGVD)
HYDROGRAPH
13.0
A
12.0
B
11.2
C
THOUSAND CFS
0
1
2
3
4
5
6
7
8
4
5
6
7
8
9
10
11
12
13
14
15
16
17
TIME, HOURS
A
B
C

FIGURE A-7C

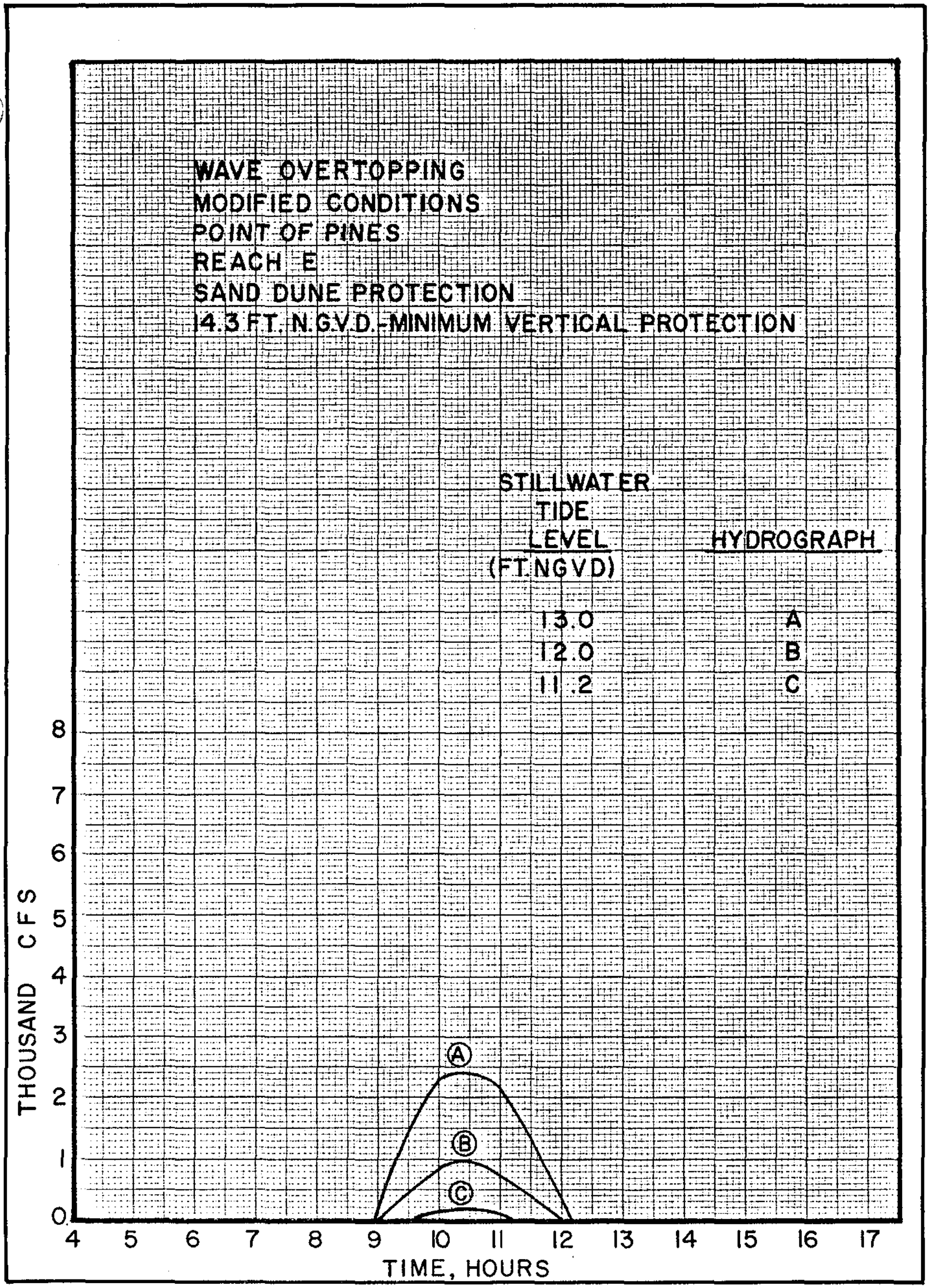

WAVE OVERTOPPING
MODIFIED CONDITIONS
POINT OF PINES
REACH E
SAND DUNE PROTECTION
14.3 FT. N.G.V.D.-MINIMUM VERTICAL PROTECTION
STILLWATER TIDE LEVEL (FT.NGVD)
HYDROGRAPH
13.0
A
12.0
B
11.2
C
THOUSAND CFS
0
1
2
3
4
5
6
7
8
4
5
6
7
8
9
10
11
12
13
14
15
16
17
TIME, HOURS

FIGURE A-7D

INTERIOR HYDROLOGY

A-13. DESCRIPTION OF AREA

Point of Pines is a residential area in northern Revere located north of Carney Circle and bounded on the west by Lynn Way highway, on the east by the ocean and on the north by the Saugus River. The boundaries of the Point of Pines area and its interior watershed are one and the same, and the area is about 60 acres in size. Its topography is very flat with only about 5 feet variation in ground elevation throughout the area. Natural drainage is generally through the center of the area in a south to north direction. Minimum elevations in the area range from about 10 feet NGVD in the southern end to about 6 feet in the northern end. This difference in elevation is representative of the drainage gradient through the area over a distance of about 1,500 feet. The area is protected against frequent tidal flooding by a combination of concrete seawalls and sand dune dikes extending along Rice Avenue and the Saugus River from Carney Circle to the Point of Pines Yacht Club. A general plan of the area is shown on plate A-1.

A-14. DRAINAGE SYSTEM

Point of Pines storm drainage is discharged by a trunkline storm sewer flowing north through the center of the area and outletting to the Saugus River just east of the Point of Pines Yacht Club. The trunkline drain is 36 inches in diameter at its northern outlet and is capable of discharging about 30 cfs by gravity at a velocity of 4-5 feet per second. Thirty cubic feet per second is equivalent to a rainfall runoff rate of 0.5 inch per hour from the interior watershed area of 60 acres. The location of the storm drain collector system is shown on plate A-2. The 36-inch diameter gravity drain is equipped with a flat gate where it passes through the storm water pumping station.

A-15. STORM DRAINAGE PUMPING STATION

There exists a storm water pumping station, at the outlet of the trunkline storm drain just east of the Point of Pines Yacht Club, for discharging drainage during storm tide. This station has its own 36-inch discharge line running parallel to the gravity line and discharging to the Saugus River. The station is equipped with twin 25 HP electrically driven propeller pumps with a minimum capacity of 4,500 GPM (10 cfs) each, for a total capacity of 20 cfs. One of the pumps is equipped with a combination drive permitting switching to a standby gasoline engine. Flood problems were reportedly compunded during the record February 1978 flood event when electric power was lost and the gasoline power failed to operate. However, the standby gasoline power has since been upgraded.

A pumping rate of 20 cfs is equivalent to a rainfall-runoff rate of about 0.33 inch per hour from the 60 acres of interior area. Location of existing pumping station is shown on plate A-1.

A-16. INTERIOR STORAGE CAPACITY

Because of the very flat topographic character of the Point of Pines area, any shallow surface ponding extends over a wide area. Also streets in the area generally run perpendicular to the natural flow path, therefore they do not serve to expedite the transmission of any waters in excess of trunkline or inlet capacities. In the event of excess runoff, ponding occurs at the low points in streets until curb deep before flowing north over land. This hydraulic characteristic results in widely distributed temporary ponding in the event of excess interior runoff and/or tidal overtopping.

An interior storage capacity curve for the area was estimated by planimetering 2-foot contour maps of the area and computing storage first as a flat reservoir and then secondly adjusting the curve at the lower elevations to reflect the wedge storage created by the hydraulic gradient through the area. The developed curves are shown on plates A-3 and A-4. The curves were developed to reflect reduced gradient with increasing ponding depths, with storage becoming a flat pool at a ponding elevation of 11.5, as shown by the adopted capacity curves. Relative elevations, versus total storage, at the selected index stations in the area are also shown.

A-17. INTERIOR RAINFALL-RUNOFF

Tidal flooding has been the prime source of extensive flooding in the Point of Pines area and according to residents, interior flooding due to interior rainfall runoff is mostly of a nuisance category. It is reported that shallow ponding occurs in low areas along the alignment of the storm drain during periods of heavy rainfall when the tide is in. Rainfall duration-frequency data applicable to Revere, as reported in US Weather Bureau TP #40, is listed in table A-11. The all-season 20 percent chance (5-year frequency) one hour rainfall is 1.5 inches per hour. In comparison, the maximum one hour rainfall experienced during four relatively recent tidal flooding events were in the order of 0.3 to 0.5 inch per hour. Rainfall amounts associated with the coastal storms of 1968, 1972, 1978, and 1979 are listed in table A-12.

The soils in the Point of Pines are quite porous and it is believed that much of normal rainfall-runoff between tides is temporarily stored by soil infiltration. However, during extended rainfall there are times that the soil becomes saturated and surface ponding occurs. An analysis of interior runoff potential was made using various frequency two-hour

TABLE A-11

RAINFALL - FREQUENCY - DURATION
USWB TECHNICAL PAPER 40
BOSTON, MASSACHUSETTS

Annual Frequency	Duration in Hours				
	1	2	6 (Inches)	12	24
20% (5 yr. freq.)	1.5	2.0	2.8	3.4	4.0
10%	1.8	2.3	3.3	3.9	4.6
2%	2.4	3.1	4.3	5.1	6.0
1% (100 yr. freq.)	2.6	3.3	4.7	5.8	6.8
SPS	3.5	4.8	9.0	10.6	12.4

TABLE A-12

RECENT TIDAL FLOODS IN REVERE
COMPARATIVE HYDROLOGIC DATA

	FLOOD EVENTS			
	7 Feb 1978	19 Feb 1972	25 Jan 1979	12 Nov 1968
Ocean Tide (Ft NGVD)	10.3*	9.1	9.3	7.7
Tide Frequency (%)	1	10	7	80
Max. Wind (Fastest Mile - MPH)	44	47	45	54
Wind Direction	NE	NE	E	NE
Interior Elevation				
Zone 4	9.1	8.3	7.4	Indeterminate
Zone 3	10.0	9.0	Indeterminate	"
Zone 2	12.0	10.4	9.5	"
Zone 1	13.0	11.1	10.3	"
Estimated Interior Frequency	1	10	20	"
Maximum One-hour Rainfall (In.)	0.2	0.5	0.3	0.3
Storm Rainfall (In.)	2.8/48 hr.	2.5/24 hr.	1.8/24 hr.	2.1/24 hr.

*On 6 Feb 1978 tide was 10 feet and maximum wind 61 mph

rainfall amounts and high antecedent water table conditions. Peak runoff rates were estimated by "rational" formula using the maximum one-hour rainfall rate and a runoff coefficient "C" of 0.7. The resulting triangular hydrographs are graphically illustrated on plate A-4. The resulting ponding levels with various pumping capacities are also shown on plate A-4. This analysis was used as a basis for estimating post project residual flood potential for nontidal overtopping conditions. Correction was made for the watershed gradient and resulting "wedge" storage in determining the ponding levels at each index zone.

A-18. INTERIOR FLOOD LEVELS

a. General. Tidal flooding in the Point of Pines area presently occurs first with wave overtopping in the north end at a relatively low area near the Point of Pines Yacht Club. Residents report that waves frequently overtop the protection at this location and during minor storms the water flows into the street drains and back out to sea; however, during severe storms, like the February 1978 event, the tidal inflow is "overwhelming", resulting in extensive flooding. This low area would experience more frequent and greater overtopping except that it faces the Saugus River and is somewhat protected from the direct attack of ocean waves. With increasing storm intensity, the second point of overtopping is reportedly at the southern end of Point of Pines near Carney Circle. This area is exposed to the open ocean and receives the brunt of wind induced ocean waves. Overtopping waters in the south migrate to the north causing shallow flooding throughout the length of Point of Pines along its natural drainage course. Some tidal overtopping in the Carney Circle area also reportedly flows north on Lynn Way and then enters Point of Pines from the westerly back side. Lastly, during major tidal storms there is wave overtopping generally throughout the length of the existing line of protection along Rice Avenue.

Because overtopping occurs at different locations and there is a flood level gradient from south to north, the Point of Pines area was divided into four different flood level zones for use in flood damage surveys. The four zones were delineated as flood level isograms based on studies of the topography of the areas and reported historic flood levels. The four zones are shown on plate A-5.

b. Recent Flood Events. Comparative data for recent tidal flood events in the Point of Pines area is listed in table A-12, including recorded ocean levels, wind speeds and directions, and resulting flood levels in each of the four zones. Past flood levels are based on field interviews with residents of the area. Peoples recollection of even the most recent flood events varied and experienced flood levels for events prior to the seventies were quite indeterminate.

c. Existing Conditions Flood, Elevation Frequencies. Existing condition flood elevation frequency curves, whown on plate A-6, were developed for use in determining flood damage frequencies. The development of the frequency curves was not a precise analytical process but involved the review of historic flood information gathered from residents, consideration of the topographic and hydraulic features of the interior area, and the application of hydrologic engineering judgment. The lack of a long term systematic record of historical flood level data did not permit derivation by statistical analysis alone, and the curves were based on both analytical and subjective analysis. Over a 12-year period, 1968-1980, the Point of Pines area experienced four significant tidal flood events: 12 November 1968, 19 February 1972, 7 February 1978 and 25 January 1979. Peoples recollection of the March 1968 event was weak and experienced flood levels were not reliably established. The greatest event was that of February 1978, followed by the February 1972 and then the January 1979 event. Simply assigning Weibull plotting positions to these four events per 12-year period would suggest frequencies of 1/13 (8%), 2/13 (15%), 3/13 (23%), and 4/13 (31%), respectively. However, the February 1978 experienced levels were the greatest flood levels ever known in the Point of Pines area, and was the result of one of the greatest coastal storms ever experienced along the New England coast based on storm accounts extending over a 300-year historic period. Engineering judgment thus ruled out assigning an 8 percent frequency to an event the magnitude of the 1978. Instead, the 1978 reported interior flood elevations were assigned a 1 percent frequency, the frequency of the 1978 storm tide based on a statistical analysis of long term storm tide records for Boston Harbor, including adjustment of historical data for the gradual long term rise in ocean level. The experienced February 1972 levels were the second highest in the 12-year period and could justifiably be assigned a 2/13 (15%) annual probability Weibull plotting position. This frequency was considered the higher limit for the 1972 event. However, if the 1978 event was treated as a statistical outlier, then the frequency of the 1972 event could be as low as 1/3 (8%). Thus it was concluded that the frequency of the experienced 1972 event was probably between the limits of 8 percent and 15 percent. The finally adopted frequency was 10 percent. The January 1979 event, the third event in magnitude, during the 12 year period was assigned a 20 percent probability based on its Weibull plotting position without adjustment. The lower, more frequent range of the curves were then based on the lowest ground elevation in each zone and the estimated frequency of tidal flooding in the zone. In the lower zone near the yacht club the start of minor tidal flooding was considered about a two-year frequency (50 percent chance) event, whereas, in the highest zone near Carney Circle the start of tidal flooding was believed more nearly in the 5 to 10-year frequency range. In the upper rarer range of the frequency curves, for floods greater than the February 1978 event, the curves were drawn asymptotic to the developed ocean stillwater tide frequency curve, based on the premise that under such storm conditions, the existing protective structures would serve only as a breakwater and interior flood levels would eventually approach ocean stillwater levels.

d. Modified Elevation Frequencies. The theoretical tidal overtopping rates and volumes computed by others and reported earlier in this appendix, were used in arriving at project modified interior elevation frequency curves. The theoretical overtopping computations were based on a sustained wind speed of 60 mph and rates and volumes were computed for a range of ocean stillwater levels for both existing and modified conditions. Results were similar to those of the Roughans Point study, in that theoretical overtopping volumes were somewhat greater than those indicated by historic interior flood levels and volumes. Also, comparisons at Point of Pines were more difficult because of the storage gradient in the interior, thus an inability to establish past interior flood volumes with any degree of precision. The computed theoretical overtopping data was used to compute interior flood levels, not directly but in proportion to relative reductions in overtopping volumes. Modified interior elevation frequencies were determined as follows:

(1) The theoretical tide level and frequency at which overtopping would first occur, under modified conditions, established the starting frequency for the lowest end of the modified curves.

(2) Modified elevations for mid-range frequencies, were reduced relative to existing condition elevations in proportion to existing versus modified theoretical overtopping volumes.

(3) Modified elevation frequency curves (in the upper limits of the frequency range) were drawn asymptotic to the unmodified curves at the levels where computed overtopping became major.

Modified elevation frequencies for the four flood elevation zones are shown on plate A-7. Stages in zones 1 and 2 were based on overtopping vomumes along line of protection sections B, C and D, whereas, elevations in zones 3 and 4 were based on overtopping volumes for the entire project area. During current DPR studies, screening of alternative levels of protection were limited to sections B, C, D.

A-20 INTERIOR DRAINAGE PROVISIONS

a. Collector Drains: No improvements or modifications will be made to existing interior storm drainage collectors as part of the proposed tidal flood control project. Any improvements in the system performed during, or after, project completion would be a local cost and responsibility.

b. Pumping Station: The existing pumping station with a capacity of about 20 cfs is considered reasonably adequate for discharging interior rainfall runoff alone during high tides, in the absence of tidal overtopping. No rehabilitation or improvements to the pumping station will be made a part of the proposed project. Proper operation and maintenance, along with any future improvements would be a local cost and responsibility.

As part of the planned tidal flood control project, emergency sluice gate closures will be provided where the discharge lines, to the Saugus River, pass through the line of protection.

c. Gravity Outlets: A supplemental36-inch diameter gravity drain will be provided extending from a catchbasin on Rice Avenue through the line of protection just east of the existing pumping station. This drain will supplement the existing 36-inch drain to discharge surface waters that would otherwise be intercepted by the line of protection in the event of an intense rainfall-runoff occurrence under normal tide conditions. Discharges will be conveyed from the line of protection to the Saugus River in the existing twin 36-inch diameter drains. The gravity drains will be equipped with flap gates and emergency sluice gate closures at the line of protection. The outlets will have a combined maximum capacity of about 100 cfs equivalent to the peak one percent chance interior rainfall-runoff.

The two outlets will also serve to release interior waters in the rare event of appreciable post project tidal overtopping, once the storm tide receded. The stoplog passage through the line of protection near the pump station would also serve such an emergency purpose.

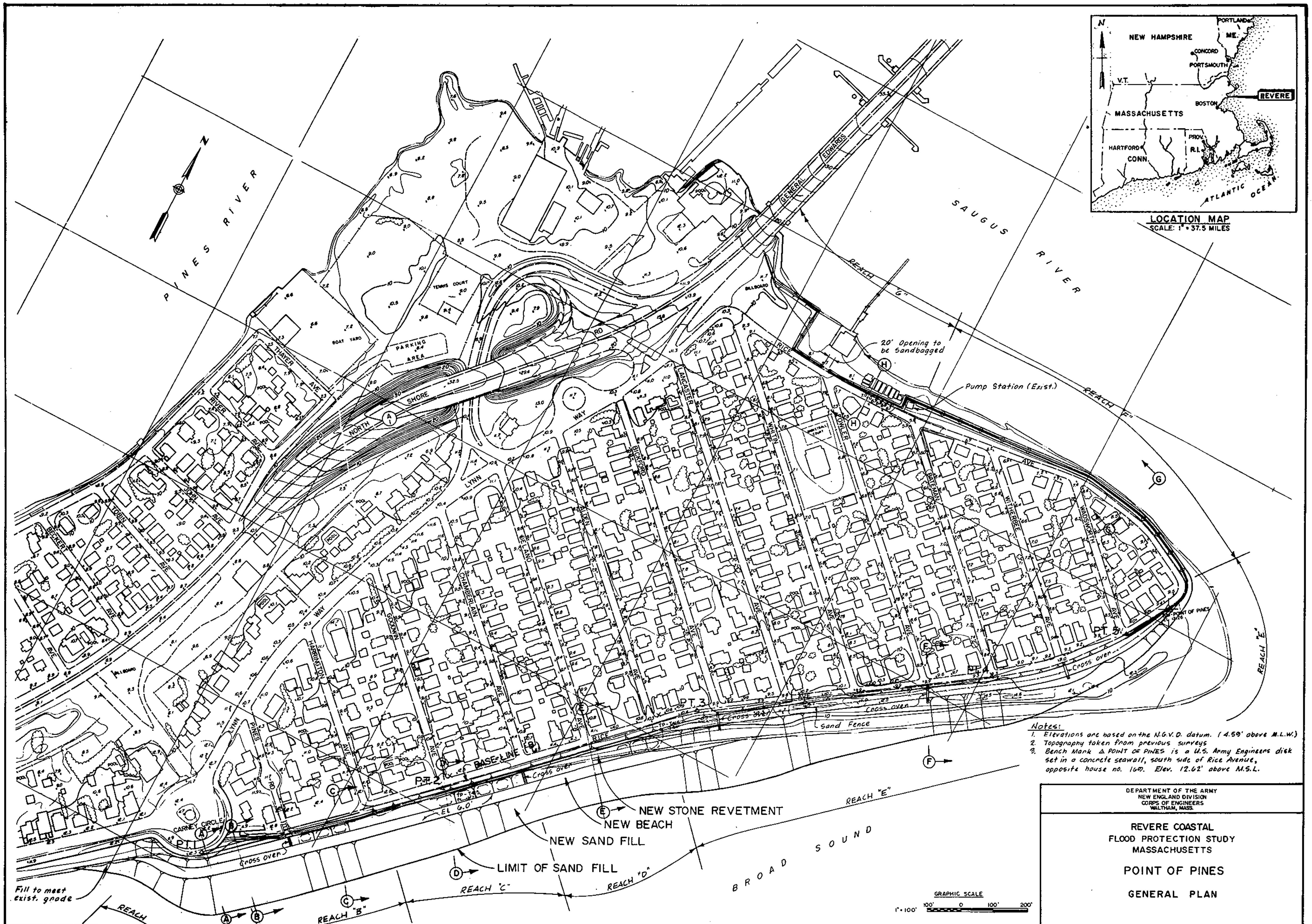
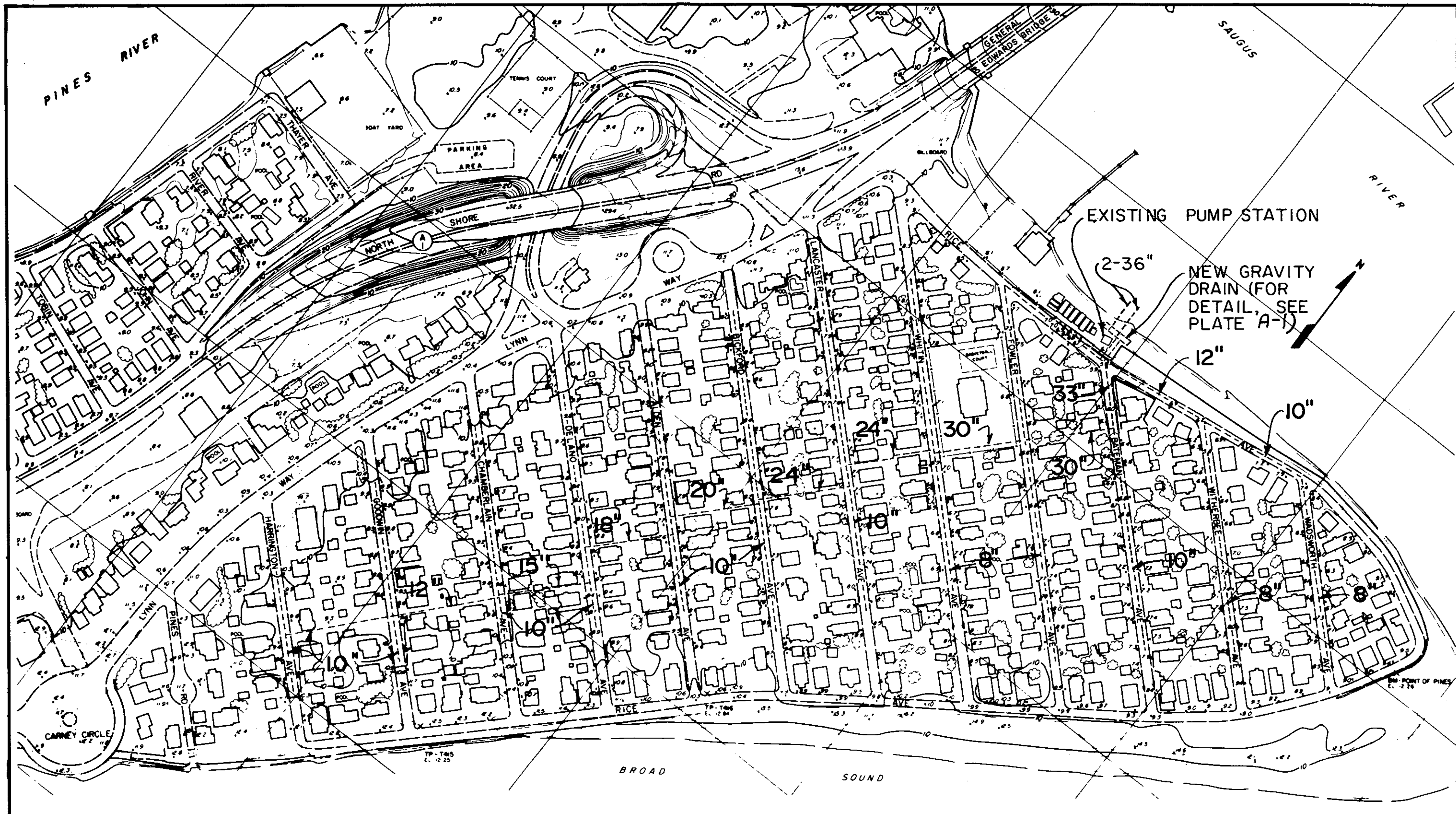

LOCATION MAP
SCALE: 1" = 37.5 MILES
NEW HAMPSHIRE
ME.
PORTLAND
CONCORD
PORTSMOUTH
VT.
MASSACHUSETTS
BOSTON
REVERE
HARTFORD
CONN.
PROV.
R.I.
ATLANTIC OCEAN
PINES RIVER
SAUGUS RIVER
BROAD SOUND
N
GENERAL EDWARDS
NORTH SHORE RD
LYNN WAY
RICE AVE
CARNEY CIRCLE
BOAT YARD
PARKING AREA
TENNIS COURT
BILLBOARD
20' Opening to be Sandbagged
Pump Station (Exist.)
POINT OF PINES
PT. 1
PT. 2
PT. 3
PT. 5
BASE LINE
EL 6.0'
Cross over
Sand Fence
NEW STONE REVETMENT
NEW BEACH
NEW SAND FILL
LIMIT OF SAND FILL
Fill to meet exist. grade
REACH "A"
REACH "B"
REACH "C"
REACH "D"
REACH "E"
REACH "F"
REACH "G"
GRAPHIC SCALE
1" = 100'
100' 0 100' 200'
Notes:
1. Elevations are based on the N.G.V.D. datum. (4.59' above M.L.W.)
2. Topography taken from previous surveys
3. Bench Mark △ POINT OF PINES is a U.S. Army Engineers disk set in a concrete seawall, south side of Rice Avenue, opposite house no. 160. Elev. 12.62' above M.S.L.
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.
REVERE COASTAL
FLOOD PROTECTION STUDY
MASSACHUSETTS
POINT OF PINES
GENERAL PLAN

PLATE A-1



SCALE

100 0 100 200 300 400

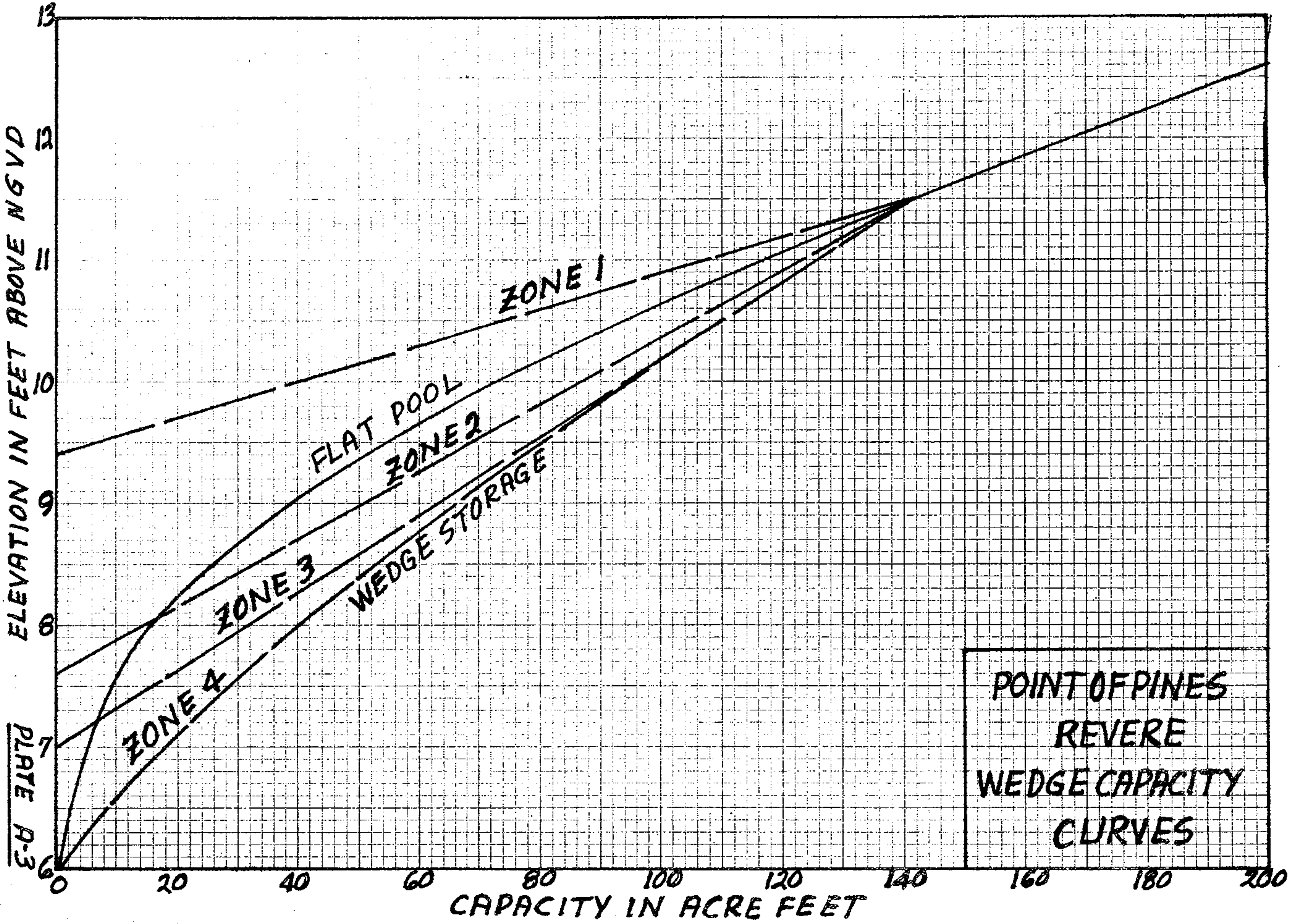
500 FOOT GRID BASED UPON MASSACHUSETTS RECTANGULAR GRID SYSTEM

NATIONAL GEODETIC VERTICAL DATUM OF 1929

DATE OF PHOTOGRAPHY - 2-7-81
CONTOUR INTERVAL - 2 FT.

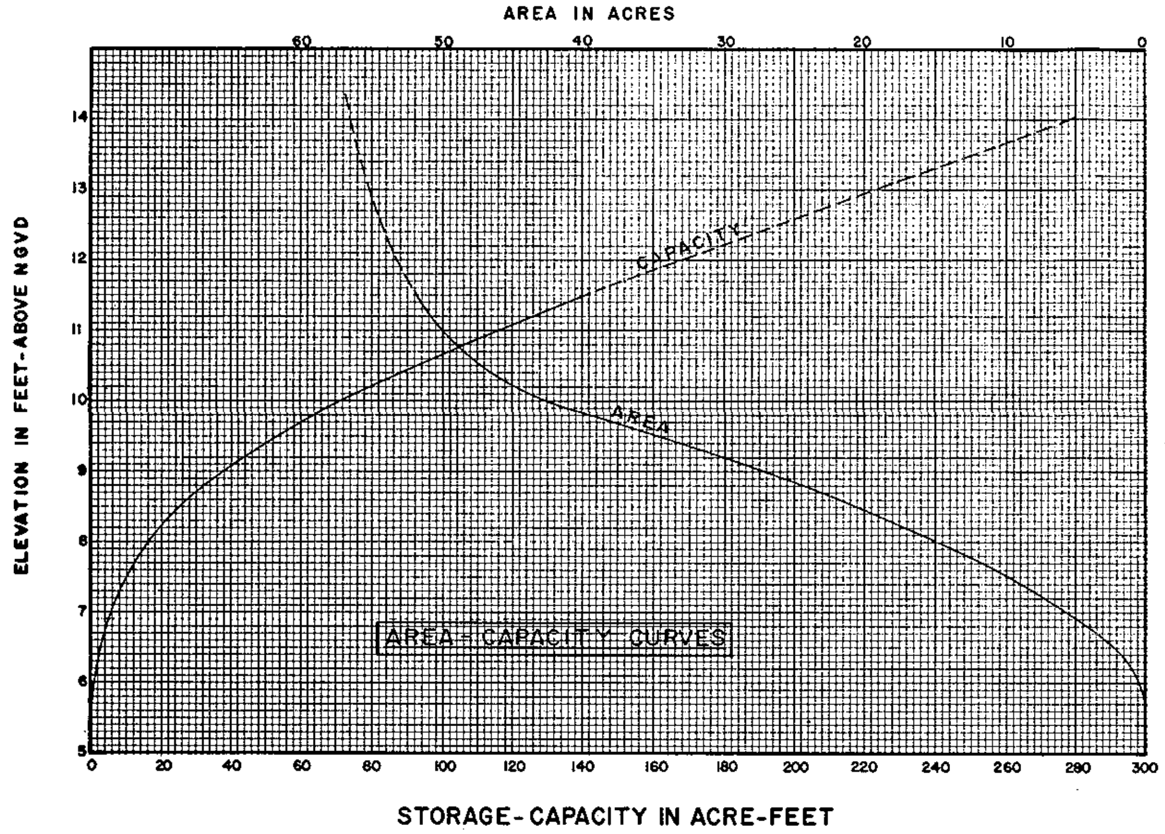
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

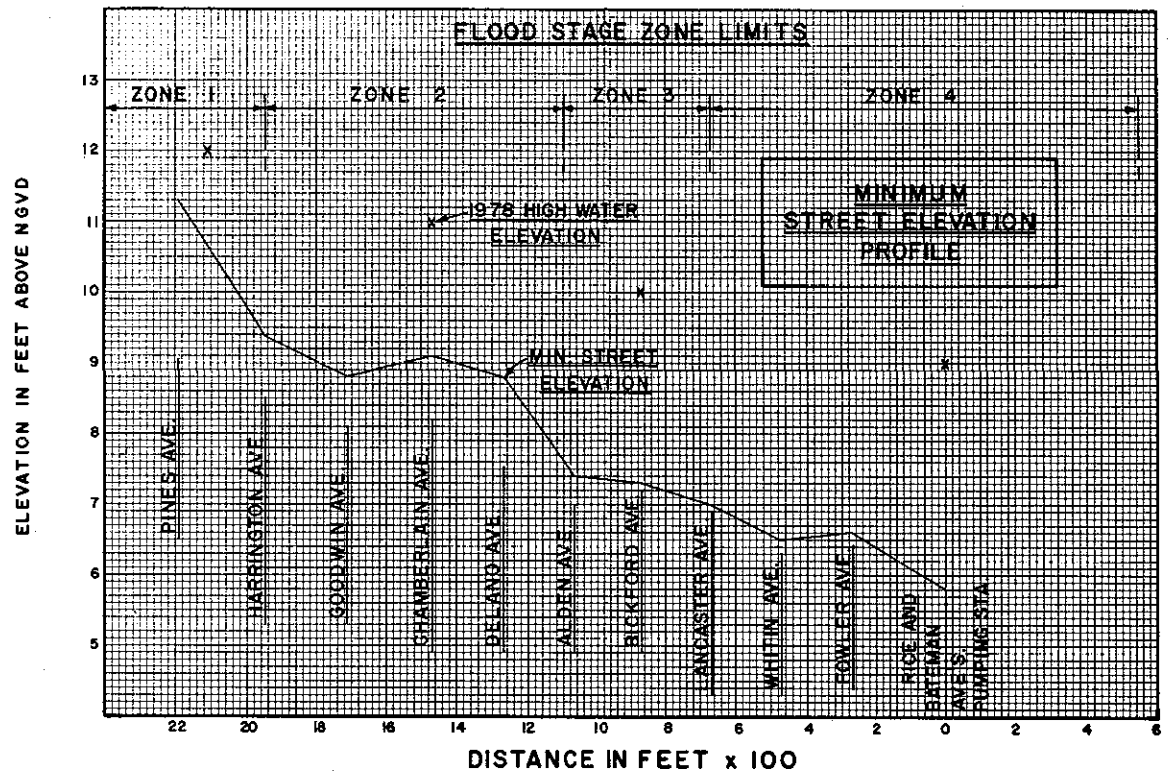
COASTAL FLOOD PROTECTION
POINT OF PINES, REVERE
MASSACHUSETTS
EXISTING STORM DRAINS

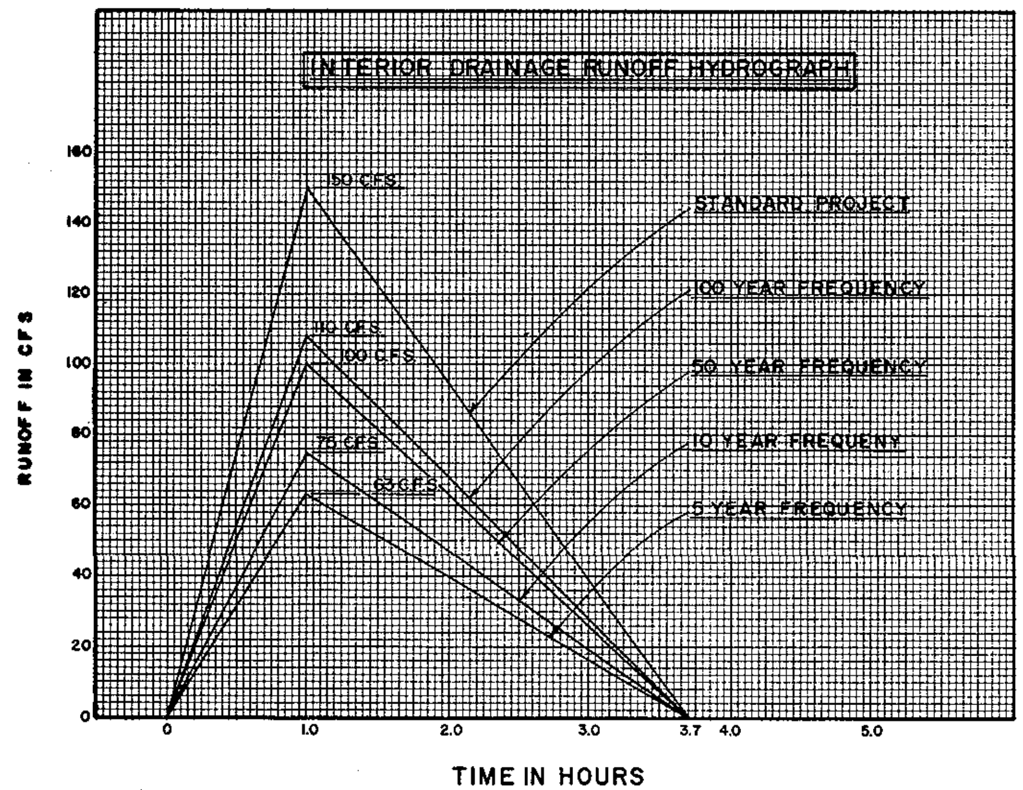


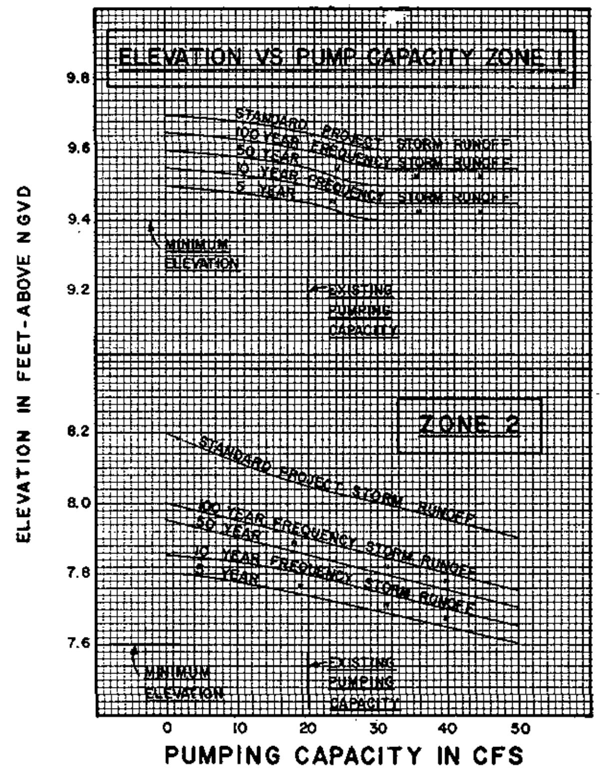
POINT OF PINES
REVERE
WEDGE CAPACITY
CURVES
ELEVATION IN FEET ABOVE NGVD
CAPACITY IN ACRE FEET
ZONE 1
FLAT POOL
ZONE 2
ZONE 3
ZONE 4
WEDGE STORAGE
13
12
11
10
9
8
7
6
0
20
40
60
80
100
120
140
160
180
200

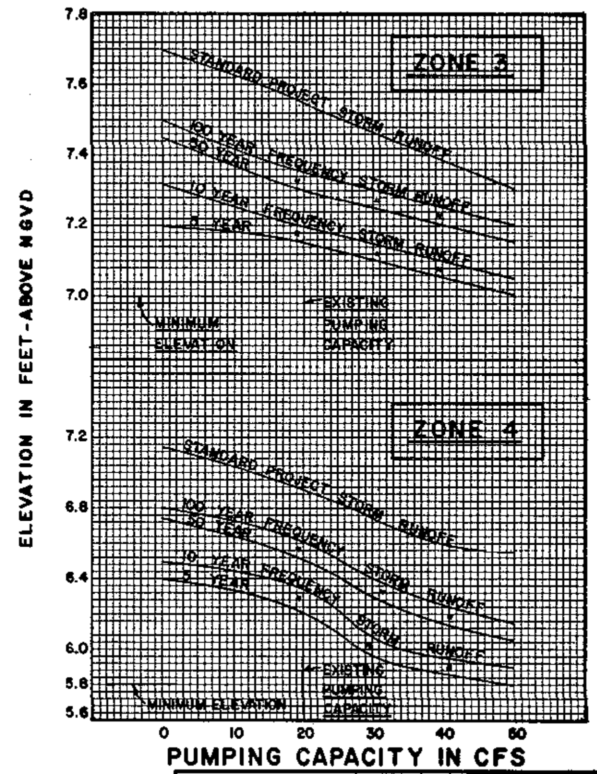
PLATE A-3











DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

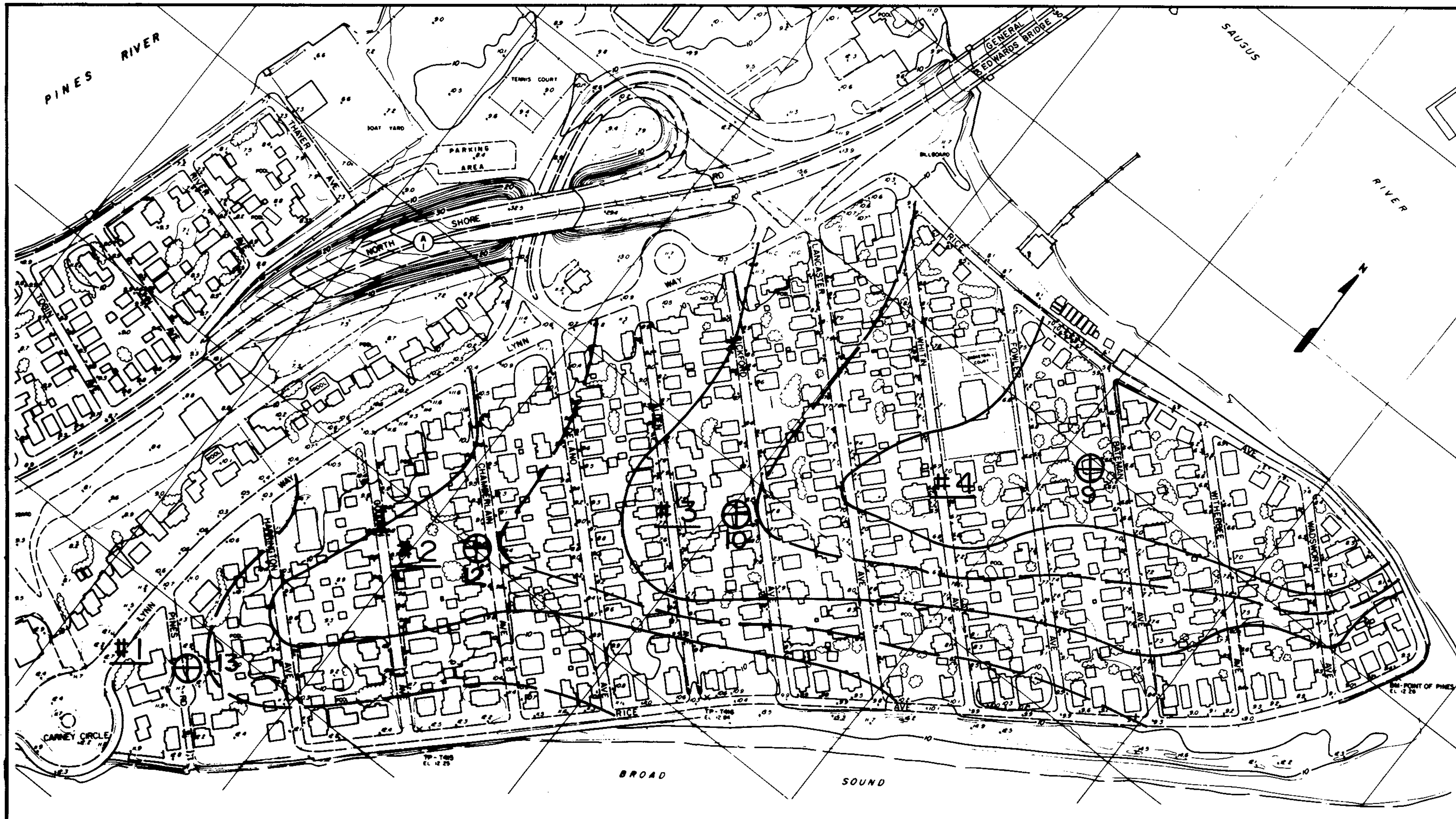
COSTAL FLOOD PROTECTION

REVERE, MASSACHUSETTS

POINT OF PINES

INTERIOR RUNOFF ANALYSIS

PLATE A-4



LEGEND

#2 ZONE NUMBER

INDEX LINE EL ⊕10

LIMIT OF ZONE

SCALE

100 0 100 200 300 400

500 FOOT GRID BASED UPON MASSACHUSETTS RECTANGULAR GRID SYSTEM

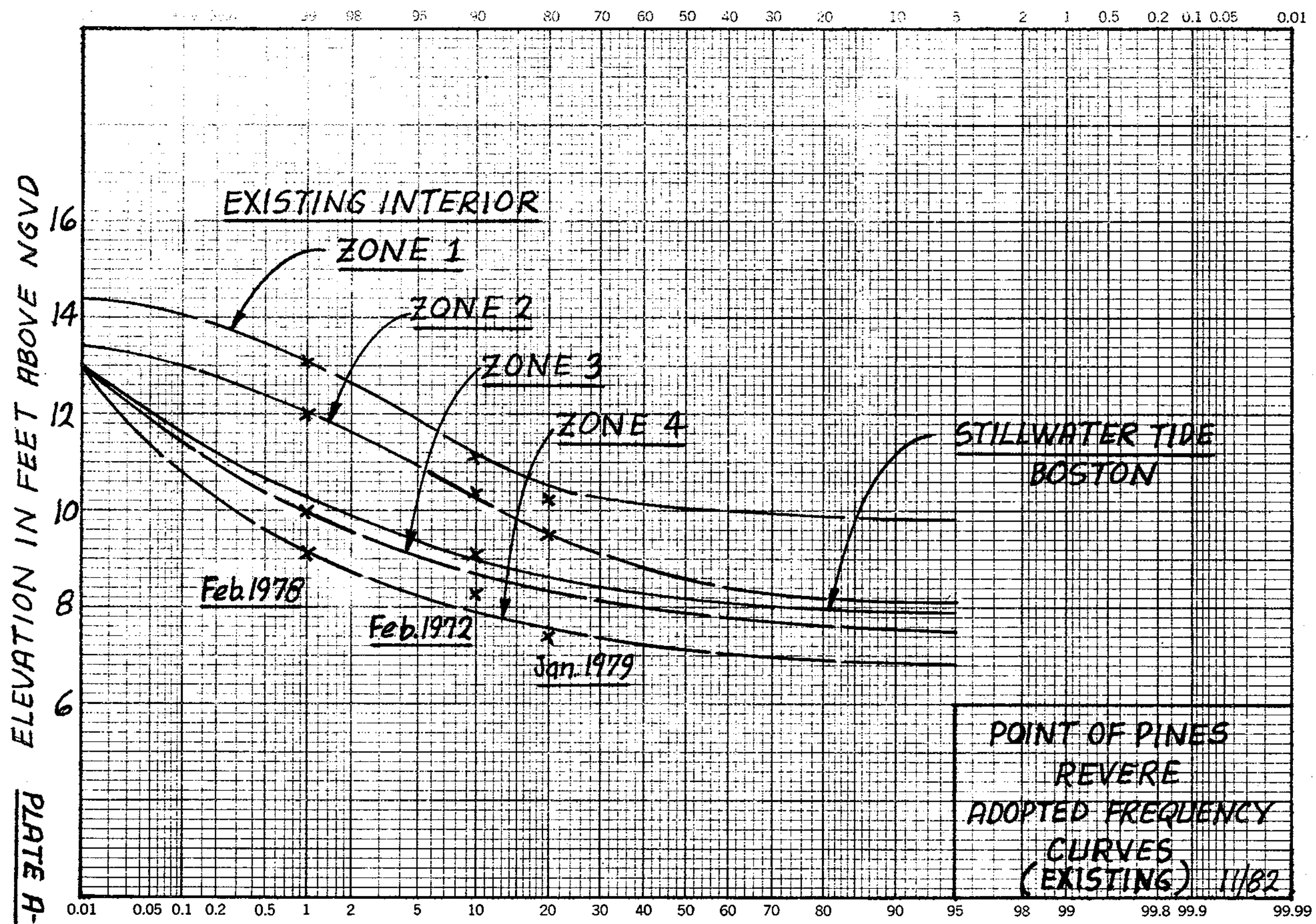
NATIONAL GEODETIC VERTICAL DATUM OF 1929

DATE OF PHOTOGRAPHY - 2-7-81

CONTOUR INTERVAL - 2 FT.

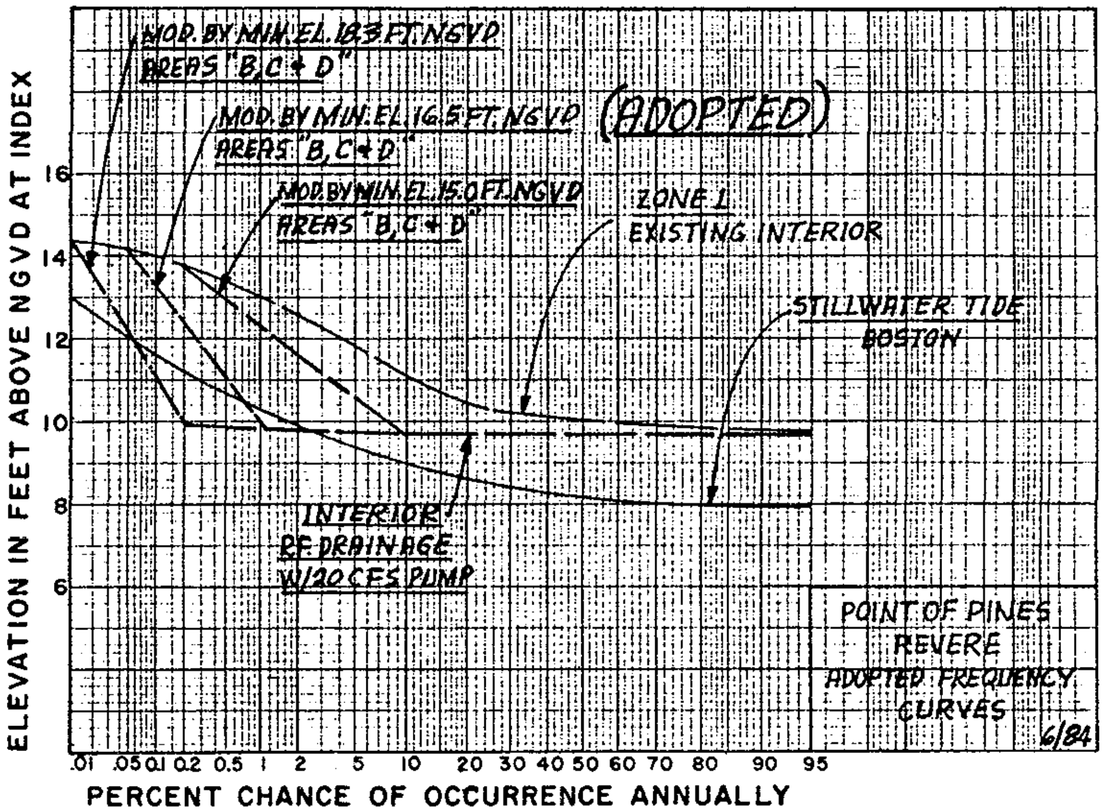
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

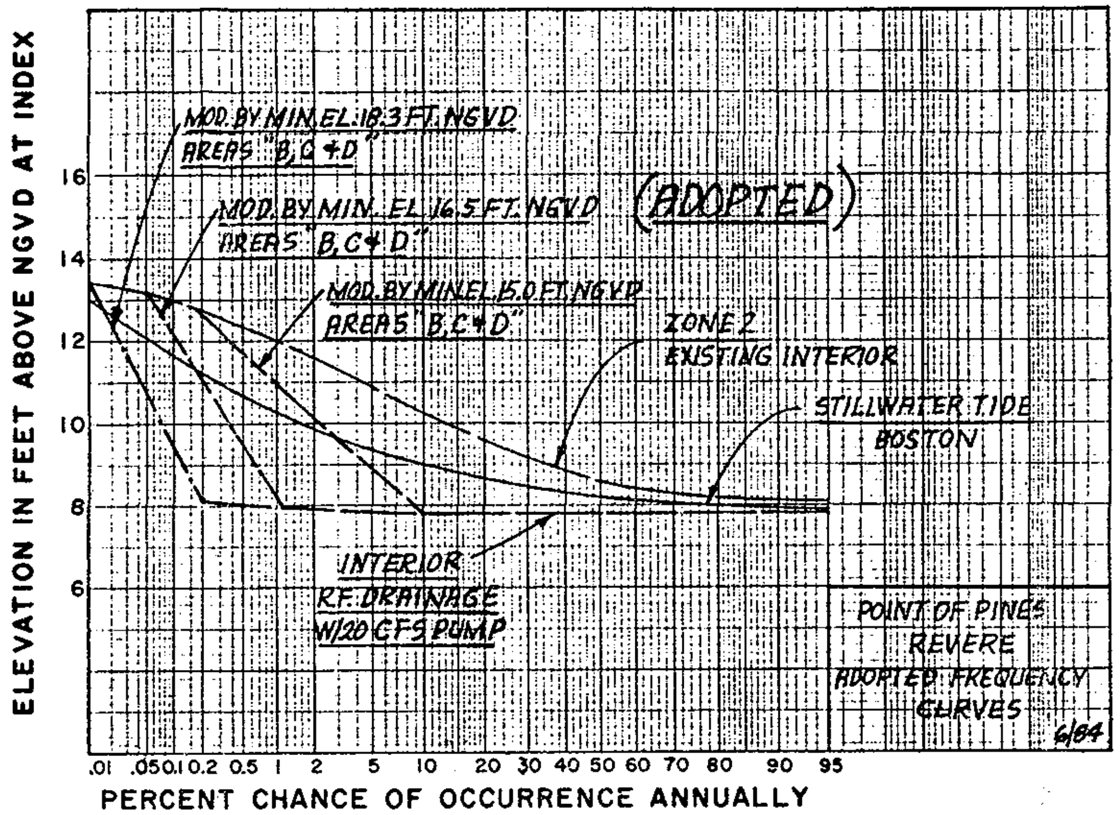
COASTAL FLOOD PROTECTION
POINT OF PINES, REVERE
MASSACHUSETTS
INDEX ZONE LIMITS

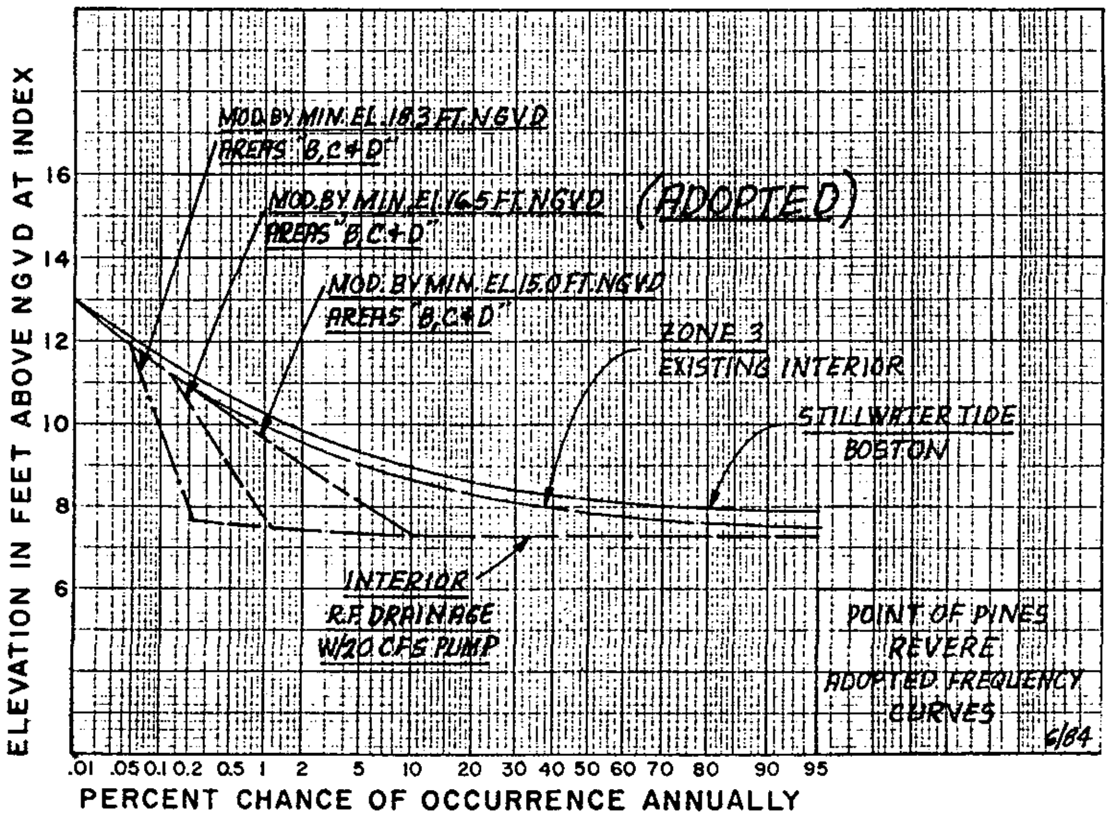


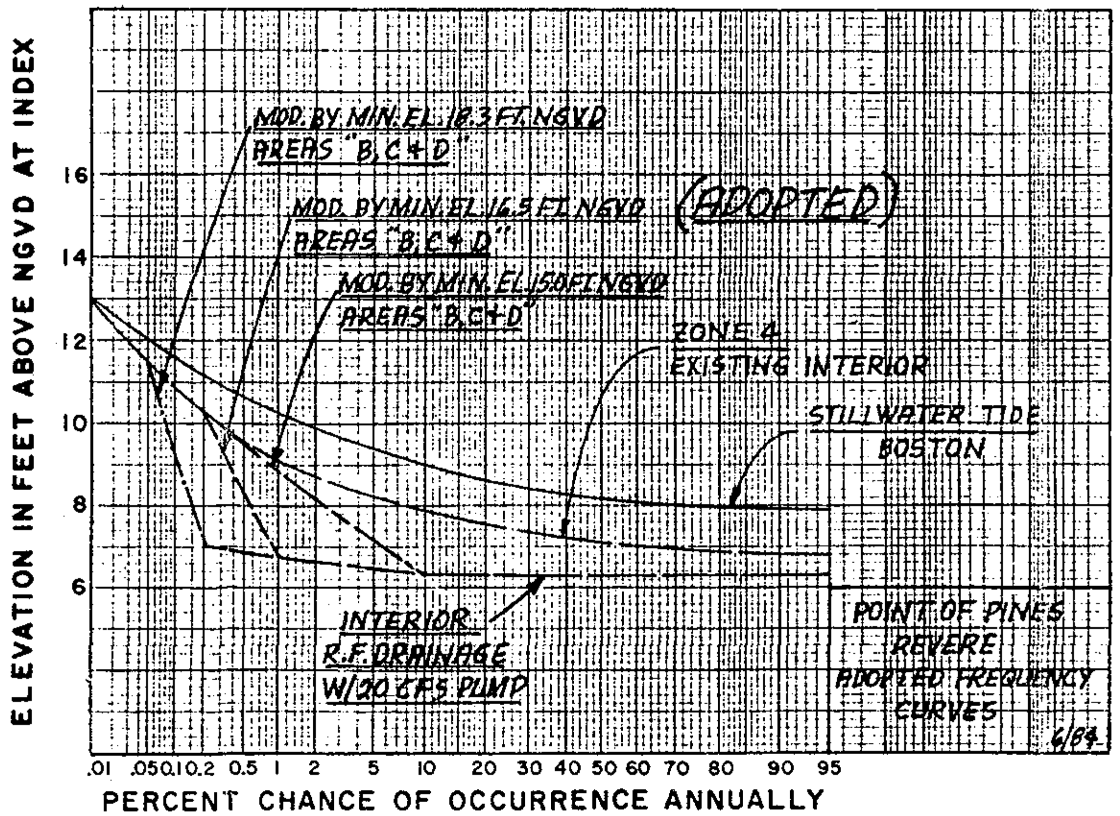
EXISTING INTERIOR
ZONE 1
ZONE 2
ZONE 3
ZONE 4
STILLWATER TIDE BOSTON
Feb. 1978
Feb. 1972
Jan. 1979
ELEVATION IN FEET ABOVE NGVD
POINT OF PINES
REVERE
ADOPTED FREQUENCY CURVES
(EXISTING) 11/82

PLATE A-6





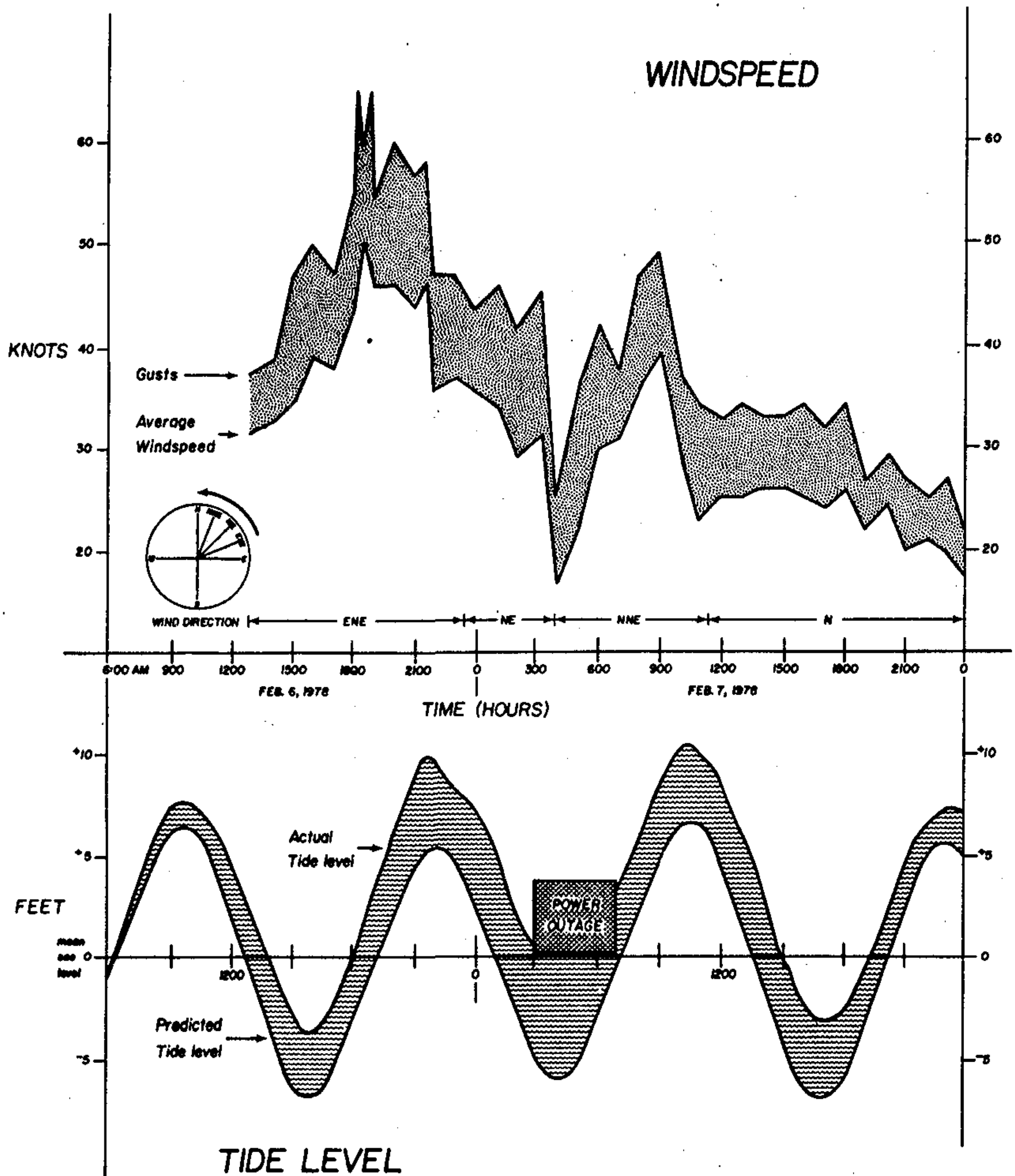




DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

COASTAL FLOOD PROTECTION
REVERE, MASSACHUSETTS
POINT OF PINES
(MODIFIED AND ADOPTED)
ELEVATION FREQUENCY CURVES

PLATE A-7



Source: U.S. Weather Bureau Station, Boston, MA
NOAA, National Climatic Center, Asheville, NC

METROPOLITAN DISTRICT COMMISSION
ENVIRONMENTAL IMPACT REPORT
FOR THE
REVERE BEACH DEVELOPMENT PROJECT

TIDE LEVEL AND WINDSPEED VS. TIME FOR THE STORM OF FEBRUARY 6 AND 7, 1978.

Camp, Dresser & McKee, Inc.
in Association With
Alan M. Voorhees & Assoc., Inc. Bolt Beranek & Newman, Inc.

Plate A-8

Reprinted from: Environmental Impact Report for the Revere Beach Development Project, Metropolitan District Commission, 1978

APPENDIX B

GEOTECHNICAL ENGINEERING

DETAILED PROJECT REPORT

POINT OF PINES

REVERE, MASSACHUSETTS

COASTAL FLOOD PROTECTION PROJECT

GEOLOGY, EMBANKMENTS AND FOUNDATIONS

TABLE OF CONTENTS

GEOTECHNICAL APPENDIX

POINT OF PINES, REVERE, MA - DPR

A. PERTINENT DATA

1. Purpose. Coastal flood protection.

2. Location.

State - Massachusetts
County - Middlesex
City - Revere

3. Design Storm.

Frequency - 100 year
Design Stillwater Elevation (SWL) - 10.3 feet NGVD
Design Wave - Breaking wave (Hb)
Hb = 10.4 feet reach A-D
Hb = 2.0 feet reach E-G

4. Embankment.

Type Riprap revetment

Top Elevation 16.0 feet NGVD

Max. height above existing ground 17.0 feet at oceanside toe

Slopes oceanside 1V on 3H, landside varies

Total length 1,750 feet

Top width 10 feet

5. Precast Concrete Wall

Top Elevation 13.3 feet NGVD

Max. height above existing ground at oceanside toe 6.5 feet

Total length 1,700 feet

B. INTRODUCTION

6. Location and Description of Project. The Point of Pines Coastal Flood Protection Project is located in the city of Revere, Massachusetts, on the northern extreme of Broad Sound between the communities of Winthrop and Lynn, Massachusetts. Point of Pines is exposed to the sea from the southeast by Massachusetts Bay. The purpose of the project is to protect predominantly residential property from coastal flooding wave action during tidal surges. The existing revetment, cast-in-place and precast concrete walls will be replaced, upgraded, or added to by a newly designed revetment and precast concrete wall system. This system will run along the shore of Point of Pines extending from Carey Circle to the northern most tip at Point of Pines and then west along the Saugus River to the General Edwards Bridge. The location, alignment and pertinent details of the structures are shown on Plates 5 and 6.

7. General. The purpose of this appendix is to present the analyses and results of soils and engineering design studies and the results of subsurface investigations made (a) for the design of the proposed embankments forming revetments, (b) for determining foundation soils'parameters for proposed walls and other concrete structures, and (c) to determine the characteristics and distribution of materials to be excavated. The subsurface investigations included geological studies, geophysical investigations, subsurface explorations, classification of materials, mechanical analysis, Atterberg Limits, specific gravities, and natural water contents. Geotechnical and coastal engineering studies were made to assist in the design of typical revetment cross-sections utilizing soils and rock materials commonly available from sources in the vicinity of the project.

8. Elevations. All elevations mentioned in this report are in reference to National Geodetic Vertical Datum (NGVD), which is the mean sea level of 1929. Mean low water (MLW) and mean high water for Revere, Massachusetts is equivalent to -4.6 ft. NGVD and +4.9 ft. NGVD, respectively.

C. TOPOGRAPHY, GEOLOGY, SEISMICITY

9. Topography. The Point of Pines area is located within the Seaboard Lowland section of the New England physiographic province. The Lowland is characterized by a roughly planar seaward-sloping region which at Point of Pines is basically flat with an average elevation around 10 feet NGVD.

10. Geology. Point of Pines is the end of a land spit that projects northward from the mainland. It is bounded by the Pines and Saugus Rivers and Broad Sound. The spit is composed of local tills and glacial outwash deposits reworked by wave action. Subsurface materials consist of unconsolidated silty sands and silty and peaty clays which are, in part, former lagoon deposits. The bedrock, the Cambridge Argillite, is well in excess of the maximum 30 foot boring depth. There are no construction problems anticipated from existing foundation materials. However, since the natural nourishment of Point of Pines is from a net northward drift of sand, the effects on sand movement of existing and planned updrift structures need to be further evaluated in the final design.

11. Seismicity. According to boundaries defined in ER1110-2-1806, the project area is in Seismic Zone 3. The regulation prescribes that the seismic coefficient method be used to evaluate the sliding and overturning stability of all concrete structures, and for this purpose a coefficient of 0.15g is to be used. In addition, a dynamic response type of stress analysis is required for concrete structures.

D. SUBSURFACE INVESTIGATIONS

12. Subsurface Explorations. In conjunction with the preparation of this report, eight 30-foot foundation drive sample borings were completed in 1982. Additional subsurface exploration data, including foundation boring records provided by the Massachusetts Department of Public Works, were also utilized in assessing the foundation conditions at Point of Pines. Location of all subsurface explorations utilized for this project are shown on the plan of explorations, Plate B-1. No explorations were made for rock or soil borrow. Soil and rock construction materials are planned to be obtained from commercial sources. The completed subsurface exploration and soil testing program is considered adequate for design purposes and construction control. All excavations shall be used as inspection trenches and limits of excavations will be adjusted depending on materials removed. Classification and description of soils found in foundation explorations completed specifically for this project in 1982 are shown on the Geologic Log Profile Plate B-2.

13. Geophysical Investigations. Ground-penetrating radar and electrical resistivity surveys were made in 1982 for the purpose of delineating any extensive subsurface organic deposits. The data indicated more or less horizontal deposits of consolidated sediments with little or no organic layers above the salt water interface. These geophysical methods were unable to define sub-interface features.

14. Laboratory Tests. All laboratory tests were performed in accordance with current standard procedures for laboratory tests of soils for use on Civil Works Projects. All soil samples were classified in conformance with the Unified Soil Classification System. Grain size analyses, Atterberg Limit determinations, specific gravity, and natural water content tests were made on selected samples to confirm visual classifications and provide more precise data where considered necessary. Tests for shear, permeability, and consolidation were not considered necessary due to the size of the proposed structures and past experience with similar soils.

15. Presentation of Data. Plates showing laboratory soil test results and summaries of these results are shown in Attachment No. 1. Exploration field logs completed specifically for this project are shown in Attachment No. 2. No additional soil tests are anticipated at this time.

E. CHARACTERISTICS OF REVETMENT AND PRECAST CONCRETE WALL FOUNDATION SOILS

16. General. Based on the available subsurface information the soil stratigraphy for the proposed coastal flood protection alignment is consistent.

17. Distribution and Description of Materials. As indicated on the Geologic Log Profile (Plate B-2) deposits of gravelly sand, sand with gravel layers and sand extend 15 to 30 feet below the existing ground surface. A 5-foot thick surficial strata of miscellaneous fill consisting of gravel and concrete fragments was located at Boring FD 82-2. The remainder of the strata is consistent with the balance of the proposed alignment. The excavation for placement of the precast concrete walls and toe of revetment will act as an inspection trench and though not anticipated, design changes will be made accordingly. Objectionable materials such as trash, ashes, cinders, wood of organics will be removed from below all structures. Below the non-cohesive tidal deposits, silty clay was encountered in all borings except Boring FD 82-6,where sand extends to the maximum 30-foot depth explored.

18. Shearing Strength. No shear tests were performed on samples of natural or man-made fill foundation materials. The proposed revetment embankment is considered stable from shear failure due to the proposed relatively low embankment heights and ample shear strength in the granular foundation soils. On the basis of visual examination of the samples and their grain size distribution curves, exploration logs and experience with similar materials, the following minimum angles of internal friction and cohesion values are estimated for the various types of foundation materials.

Foundation Soils

a. Medium -compact sands and gravels $-\phi = 32°$ $C = 0.0$ psf

b. Loose sands - $\phi = 30°$, $C = 0.0$ psf

c. Loose sand with gravel-$\phi = 32°$. $C = 0.0$ psf

d. Medium stiff silty clay-$\phi = 0°$, $C = 500.0$ psf

19. Permeability. No permeability tests were made on foundation soils since the relative permeability characteristics can be evaluated with sufficient accuracy by visual inspection of the samples and their grain size distribution curves. The anticipated maximum differential head along the precast concrete wall reach of the protection system is 5.0 feet assuming water to top of wall, elevation 13.3 feet NGVD, which is 3.0 feet above design stillwater level.

Foundation Soils	Coefficient of Permeability (K)
Gravelly sands (SP,SP-SM)	1×10^{-3} to 1×10^{-2} cm/sec
Silty sandy gravel (GP-GM)	1×10^{-3} to 1.0 cm/sec

20. Consolidation. Consolidation tests were not performed on samples of foundation soils for this project. In light of the foundation soil profile and low compressibility characteristics of the foundation soils, settlements of any consequence are not anticipated due to proposed structural loadings.

F. DISTRIBUTION, DESCRIPTION AND USES OF EARTH MATERIALS TO BE EXCAVATED

21. General. Excavation of existing stone riprap and soils will be necessary to reshape existing slopes and provide space for proposed structure toe details. The soils removed from required excavations will be used for sand fill if meeting required specifications. All materials containing ashes, cinders, trash, organics, objectionable debris and excess materials will be spoiled off site. All the existing stone riprap will be removed and stored according to size, and utilized where meeting specifications for the proposed protection system.

G. AVAILABILITY OF REVETMENT MATERIALS AND GRAVEL

22. General. Construction materials consisting of quarry stone, spalls and gravel fill are available from operating commercial sources within a 40-mile radius of the project area.

23. Revetment Materials. The approximate quantities of construction materials required for revetment construction are 29,300 yd^3 of durable, uniform, rough angular quarry stone in the 3500-6000 lb. weight range and 16,000 yd^3 in the 300-600 lb. weight range. Also, 5,000 $yd.^3$ of bedding material consisting of well-graded quarry spalls (50 lb. to dust) will be needed..

24. Gravel Fill. Gravel fill required for placement adjacent to the precast concrete wall is estimated at 4,000 yd and shall consist of well graded sandy gravel composed of tough, durable particles of natural sand and gravel. The material shall meet the following gradation limits:

Sieve Size (U.S. Std)	Percent Passing by Dry Weight
6 inch	100
1 inch	45-90
No. 4	15-70
No. 16	7-50
No. 200	0-5

25. Sand Fill.

Sand fill being placed seaward of the protection system is estimated at 36,750 yd^3. Gradation requirements and specifications will be established during the plans and specifications stage.

H. DESIGN OF REVETMENT

26. General. The embankment for the revetment is part of a coastal flood protection project. The revetment embankment will be subjected to extreme high tides, wave action and possibly overtopping. The stillwater level (SWL) for the design storm (100-year) is elevation 10.3 feet NGVD. The maximum design breaking wave (Hb) for the 100 year storm is 10.4 feet and depth dependent. The project is being designed for this wave height between reaches A through D at its southern end.

27. Design Criteria. The revetment embankments are designed to be stable structures under the design coastal flooding and construction conditions at Point of Pines, in accordance with U. S. Army Coastal Engineering Research Center, Shore Protection Manual and Technical Notes, Department of the Army, Engineer Manual 1110-2-1913, Design and Construction of Levees and other pertinent design criteria.

28. Selected Revetment Sections. The selected revetment sections (A-E, Plate 6) are based on a stillwater elevation of 10.3 feet NGVD, design breaking wave (Hb) of 10.4 feet and a runup elevation of 18.5 feet. The design parameters used for sizing uniform stone and underlayers are as follows:

Wr = 165 lbs./ft. (unit weight of armor stone)
H = Hb = 10.4 ft. (design wave at revetment)
Ww = 64.0 lbs./ft (unit weight of water at site)
Sr = Wr/Ww = 165/64 = 2.58 (specific gravity of armor stone
Cot 0 = 3 (slope 1:3)
K = 3.5 (breaking - wave, 2 random layers, rough angular quarrystone)

The sand fill to be placed in front of the revetment (see Plate 6) was not taken into account in the development of the design breaking wave (Hb = 10.4 feet) used in the revetment stone sizing and layer thickness design. However, it is recognized that if the sandfill stays in place, it will reduce the size of the anticipated wave and elevation of runup. Therefore, scour protection has not been placed on the landside of the revetment structures in anticipation of no overtopping.

As shown on Plate 6 the revetment cross sections will consist of uniform, rough, angular quarry stone in a 7.0 foot (2 layers) armor layer overlying a 4.5 foot (2 layers) underlayer which overlies a 1.5 foot bedding layer of quarry spalls consisting of relatively well grade stone (50 lbs. to dust).

29. Construction Considerations. Portions of the proposed flood protection system will be built in the tidal zone, and will be subject to daily tide fluctuations and wave action. It is anticipated that economical placement of all embankment materials by land-operated equipment can be accomplished by working around the tide and working from high ground when necessary.

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT. NGVD	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS GRAVEL %	SAND %	FINES %	D_{10} mm	ATT. LIMITS LL	PL	SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT TOTAL	- NO4	COMPACTION DATA STND. AASHO OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	NAT. DRY DENSITY LBS/CU FT TOTAL	- NO4	OTHER TESTS SHEAR	CONSOL.	PERM.	OTHER
FD82-1	5.5'±	S-5	20.0-25.0'	CL					44	22	2.75		26.0[illegible]									Hyd.
		S-6	25.0-30.0'	CL-CH					50	24	2.78		31.48									Hyd
FD82-2	8.0'±	S-5A	23.5-25.0'	CL					43	22	2.78		26.28									Hyd.
		S-6	25.0-30.0'	CL					40	21	2.69		24.79									Hyd.
FD82-3	6.2'±	S-6	25.0-30.0'	CL					49	24	2.71		36.74									Hyd.
FD82-4	3.2'±	S-4A	18.5-20.0'	CL					47	24	2.74		30.78									Hyd.
		S-5	20.0-25.0'	CL					49	24	2.77		31.55									Hyd.
		S-6	25.0-30.0'	CH					51	25	2.76		37.99									Hyd.
FD82-5	3.0'±	S-4A	18.0-20.0'	CL							2.70											Hyd.
		S-5	20.0-25.0'	CH					51	24	2.77		33.70									Hyd.
		S-6	25.0-30.0'	CH					53	25	2.72		36.86									Hyd.
FD82-7	6.5'±	S-5A	22.8-25.0'	CL							2.79											Hyd.

Point of Pines
Revere, MA

ATTACH 1

NED FORM JUL 63 510 * PROVIDENCE VIBRATED DENSITY TEST

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS: GRAVEL %	MECHANICAL ANALYSIS: SAND %	MECHANICAL ANALYSIS: FINES %	MECHANICAL ANALYSIS: D_{10} mm.	ATT. LIMITS: LL	ATT. LIMITS: PL	SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT: TOTAL	NAT. WATER CONTENT % DRY WT: -NO4	COMPACTION DATA: STND. AASHO: OPT. WATER % DRY WT	COMPACTION DATA: STND. AASHO: MAX. DRY DENS. LBS/CU FT	COMPACTION DATA: * PVD LBS/CU FT	NAT. DRY DENSITY LBS/CU FT: TOTAL	NAT. DRY DENSITY LBS/CU FT: -NO4	OTHER TESTS: SHEAR	OTHER TESTS: CONSOL	OTHER TESTS: PERM.	
		S-6	25.0-30.0'	CL					49	24	2.73											Hyd.
FD82-7	2.8'±	S-6	25.0-30.0'	CL					53	24	2.73		38.85									Hyd.
		S-5	25.0-30.0'	CL					47	24			39.32									Hyd.

NED FORM 510 Jan 63   * PROVIDENCE VIBRATED DENSITY TEST

Point of Pines
Revere, MA

U S ARMY
CORPS OF ENGINEERS
NEW ENGLAND DIVISION

FIELD LOG OF TEST BORING

Site REVERE MA Page 1 of 3 Pages

Boring No. FD 82-1 Desig. F Diam. (Casing) 3-0"

Co-ordinates. N NOT GIVEN E

Elevation Top of Boring 5.5' M.S.L.
Total Overburden Drilled 30.0 Feet
Elevation Top of Rock NONE ENCOUNTERED M.S.L.
Total Rock Drilled 0 Feet
Elevation Bottom of Boring -24.5' M.S.L.
Total Depth of Boring 30.0 Feet
Core Recovered N/A % No. Boxes —
Core Recovered N/A Ft: — Diam. — In.
Soil Samples 2-0 In. Diam. 6 No.
Soil Samples 1-3/8 In. Diam. 1 No.

Hammer Wt. 300 lbs Boring Started 8-24-82
Hammer Drop 18
Boring Completed 8-24-82
Casing Left NONE
Subsurface Water Data — Page —
3.2' TIDAL
Obs. Well NO
Drilled By BRIGGS ENGINEERING & TESTING CO.
Mfg. Des. Drill ACKER
Inspected By: Ronald F. Bukoski
Classification By: Ronald F. Bukoski
Classification By: JP Rag[illegible] [illegible] 7 Oct 1982

0900 hrs

DEPTH 1"=1.0'	NO.	SIZE	DEPTH RANGE	BLOWS PER FT. / CORE REC'VY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
0.0–1.0				7	DROVE 2-0" I.D. x 5-0' SOLID BARREL SAMPLER FROM GROUND SURFACE TO 5.0' USING 300 lb HAMMER DROPPED 18".	SURFACE: BEACH SAND
1.0–2.0	S-1 1 JAR	2-0"	0.0 TO 5.0'	22	RECOVERED 26-0"	~~SAND, FINE~~ MEDIUM TO FINE SAND, ~~<2% non-plastic fines~~ ~~<2%~~ w/ SHELL FRAGMENTS, MOIST, LIGHT GRAYISH BROWN, (SP). w/ tr. f. gravel
2.0–3.0				36	DROVE 3-0" CASING FROM GROUND SURFACE TO 5.0'	2" SEAM OF GRAVELLY SAND AT APPROXIMATELY 2.0'
3.0–4.0				23	WASHED OUT CASING USING ROLLER ROCK BIT.	~~35-75%~~ MEDIUM TO FINE SUBROUNDED GRAVEL, COARSE TO FINE SAND, MOIST, LIGHT GRAYISH BROWN, (SW).
4.0–5.0				18		
5.0–6.0				17	DROVE 2-0" I.D. x 5.0' SOLID BARREL SAMPLER FROM 5.0 TO 10.0' USING 300 lb HAMMER DROPPED FROM 18"	~~SAND, FINE~~ MEDIUM TO FINE SAND, ~~<5% organic~~ ~~fines and~~ DECAYING WOOD, ~~<5%~~ SHELL FRAGMENTS, SLIGHT ORGANIC ODOR, SATURATED, DARK GRAY, ~~(SP)~~ (SP-SM) w/ tr. f. gravel
6.0–7.0	S-2 1 JAR	2-0"	5.0 TO 10.0'	18	RECOVERED 19-0".	
7.0–8.0				21	DROVE 3-0" CASING FROM 5.0' TO 10.0' AND WASHED OUT USING ROLLER ROCK BIT.	
8.0–9.0				21		
9.0–10.0				25		

GENERAL REMARKS: BORING DEPTHS ARE REFERENCED TO EXISTING GROUND SURFACE ELEVATION.

Site	Boring No.	Page
REVERE, MA	FD 82-1 DESIG F	2 of 3

DEPTH 1"=1.0'	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT. CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
11.0	S-3 1 JAR	2-0"	10.0 TO 15.0'	9	DROVE 2-0" I.D. x 5' SOLID BARREL SAMPLER FROM 10.0 TO 15.0' USING 300 lb HAMMER.	SAND WITH PEAT LAYERS, THIN, DISPERSE LAYERS, LESS THAN 1/8" THICK OF PEAT ~~FINE-MEDIUM TO FINE SAND, < 2% NONPLASTIC FINES,~~ ~~< 5%~~ SHELL FRAGMENTS, MODERATE ORGANIC ODOR, DARK GRAY, ~~(SP LAYERS Pt).~~ silty f. sand (SM)
12.0				11	RECOVERED 27-0"	
13.0				19	DROVE 3-0" CASING FROM 10.0 TO 15.0' AND WASHED OUT USING ROLLER ROCK BIT.	
14.0				24		
15.0				27		
16.0	S-4 1 JAR	2-0"	15.0 TO 20.0'	9	DROVE 2-0" I.D. x 5' SOLID BARREL SAMPLER FROM 15.0 TO 20.0' USING 300 lb HAMMER DROPPED 18".	SAND, WIDELY SPACED PEAT LAYERS, 4" LAYER - MEDIUM GRAVEL SIZE PARTICLES INTERSPERSED IN SAND ~~FINE-MEDIUM TO FINE SAND,~~ ~~< 5%~~ SHELL FRAGMENTS, ~~< 5% MEDIUM TO FINE GRAVEL,~~ SLIGHT ORGANIC ODOR, GRAY, ~~(SP WITH Pt).~~ silty, gravelly, f. sand (SP-SM)
17.0				11	RECOVERED 31-0"	
18.0				16	DROVE 3-0" CASING FROM 15.0 TO 20.0' AND WASHED OUT USING ROLLER ROCK BIT.	
19.0				20		
20.0				22		
21.0	NO SAMPLE		20.0 TO 22.0	7	DROVE 2-0" I.D. x 5' SOLID BARREL SAMPLER FROM 20.0 TO 25.0' USING 300 lb HAMMER DROPPED 18".	
22.0				13	RECOVERED 36"	
23.0	S-5 2 JARS	2-0"	22.0 TO 25.0'	21	DROVE 3-0" CASING FROM 20.0 TO 25.0' AND WASHED OUT ~~USING~~ USING FISHTAIL BIT.	~~SILTY CLAY, MODERATE PLASTICITY~~ MOTTLED BROWN AND GRAY silty clay ~~< 5%~~ PEAT INTERSPERSED, MODERATE DRY STRENGTH, (CL).
24.0				30		
25.0				39	DROVE 2-0" I.D. SOLID SPOON SAMPLER FROM 25.0 TO 30.0' NO RECOVERY. VERY STIFF CLAY TRAP BROKEN-OFF WHILE DRIVING. DROVE 1-3/8" I.D. SPLIT-BARREL SAMPLER FOR RECOVERY.	SILTY CLAY, ~~SAMPLE S-6~~ ~~SAME AS SAMPLE S-5~~ (CL-CH) w/tr f. sand
26.0	S-6 1 JAR	1-3/8"	25.0 TO 30.0'	7		
				11		

Site: REVERE,	Boring No. FD 82-1 DESIG. F	Page 3 of 3

DEPTH: Blows on Casing	DEPTH: 1" = 1.0'	CORE/SAMPLE: NO.	CORE/SAMPLE: SIZE	CORE/SAMPLE: DEPTH RANGE	BLOWS PER FT. / CORE RECV'Y	~~SAMPLING AND CORING~~ OPERATIONS	CLASSIFICATION OF MATERIALS
					17		S-6: SILTY CLAY (CL-CH) w/tr f sand
	28				21		
	29				24		
	30					BOTTOM OF BORING 30.0'	

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FIELD LOG OF TEST BORING

Site [illegible] Page 1 of 3 Pages

Boring No. FD 82-2 Desig. G Diam. (Casing) 3-0"

Co-ordinates. N NOT GIVEN E

Elevation Top of Boring 8.0 M.S.L.
Total Overburden Drilled 30.0 Feet
Elevation Top of Rock NONE ENCOUNTERED M.S.L.
Total Rock Drilled -0- Feet
Elevation Bottom of Boring -22.0' M.S.L.
Total Depth of Boring 30.0 Feet
Core Recovered N/A % No. Boxes —
Core Recovered N/A Ft: — Diam. — In.
Soil Samples 2-0 In. Diam. 10 No.
Soil Samples — In. Diam. — No.

Hammer Wt. 300 lb Boring Started 8-24-82
Hammer Drop 18" Boring Completed 8-25-82
Casing Left NONE
Subsurface Water Data — Page —
3.0' TIDAL
Obs. Well NO
Drilled By BRIGGS ENGINEERING & TESTING CO.
Mfg. Des. Drill ACKER
Inspected By: RONALD F. BUKOSKI
Classification By: RONALD F. BUKOSKI
Classification By: JP Rogge MultiLab 7 Oct 1982

DEPTH 1"=1.0'	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT. / CORE REC'VY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
1	S-1 1 JAR	2-0"	0.0 TO 5.0'	7	DROVE 2-0" I.D. x 5' SOLID SPOON SAMPLER FROM 0.0 TO 5.0' USING 300 lb HAMMER DROPPED 18"	SURFACE: YACHT CLUB PARKING AREA - 3/8" CRUSHED STONE
2	S-1A 1 JAR			33	SMALL BOULDER ENCOUNTERED BETWEEN 1 AND 2'.	MISCELLANEOUS FILL: GRAVELLY ~~SAND 20-30% GRAVEL TO~~ c.f sand (SP-SM) w/ ~~FINE GRAVEL AND~~ CONCRETE FRAGMENTS, ~~<10% NONPLASTIC FINES~~, DAMP, GRAYISH, ~~(SW-SM)~~.
3				10	RECOVERED 23-0"	S-1A: BOTTOM 4" OF RECOVERED SAMPLE
4				10	DROVE 3-0" CASING FROM 0.0 TO 5.0' AND WASHED OUT USING ROLLER ROCK BIT.	GRAVELLY m.f SAND, ~~<20%~~ MEDIUM TO FINE SUBANGULAR GRAVEL, ~~COARSE TO FINE SAND, MOSTLY MEDIUM TO FINE, <10% NONPLASTIC FINES~~, DAMP, GRAYISH (SP-SM).
5				15		
6	S-2 1 JAR	2-0"	5.0 TO 10.0'	9	DROVE 2-0" I.D. x 5' SOLID SPOON SAMPLER FROM 5.0 TO 10.0' USING 300 lb HAMMER DROPPED 18".	
7				19	RECOVERED 23-0".	SAND WITH GRAVEL LAYERS,
8				24	DROVE 3-0" CASING FROM 5.0 TO 10.0' AND WASHED OUT USING ROLLER ROCK BIT.	3" SEAMS OF MEDIUM TO FINE GRAVEL AT ± 12", ~~FINE MEDIUM TO FINE SAND, <5% NONPLASTIC FINES~~, Gravelly m.f sand MOIST, GRAY, (SP).
9				33		
10				26		

GENERAL REMARKS: BORING DEPTHS ARE REFERENCED TO EXISTING GROUND SURFACE ELEVATIONS.

NED [illegible] 55 (Test)

Site: REVERE, MA	Boring No. FD 82-2 DESIG. 2	Page 2 of 3

Depth: Blows on Casing	Depth: Ft./D	Core/Sample No.	Size	Depth Range	Blows per Ft. / Core Recvy	Sampling and Coring Operations	Classification of Materials
	11, 12, 13, 14, 15	S-3 1 JAR	2-0"	10.0 TO 15.0'	11, 15, 24, 22, 28	DROVE 2-0" I.D. x 5' SOLID BARREL SAMPLER FROM 10.0 TO 15.0' USING 300 lb HAMMER DROPPED 18". RECOVERED 28-0". DROVE 3-0" CASING FROM 10.0 TO 15.0' AND WASHED OUT USING ROLLER ROCK BIT.	~~SAND, FINE MEDIUM TO FINE SAND, <10% THIN~~ Br. gr - silty f sand (SM) ORGANIC SEAMS OR FIBERS, ~~<10% NONPLASTIC FINES, (SP-SM)~~).
	16, 17, 18, 19, 20	S-4 1 JAR	2-0"	15.0 TO 20.0'	5, 3, 9, 12, 17	DROVE 2-0" I.D. x 5' SOLID BARREL SAMPLER FROM 15.0 TO 20.0' USING 300 lb HAMMER DROPPED 18". RECOVERED 22 1/2". DROVE 3-0" CASING FROM 15.0 TO 20.0' AND WASHED OUT USING A ROLLER ROCK BIT.	SAND, ~~FINE MEDIUM TO FINE SAND, <5%~~ ORGANIC SEAMS, FIBERS OR SHELL FRAGMENTS, ~~<10% Non Plastic Fines~~, GRAY, silty ~~(SP-SM)~~. f sand (SM)
8-25-82	21, 22, 23	S-5 1 JAR	2-0"	20.0 TO 23.5'	7, 9, 10	DROVE 2-0" I.D. x 5' SOLID BARREL SAMPLER FROM 20.0 TO 25.0' USING 300 lb HAMMER DROPPED 18". RECOVERED 36". CHANGE IN MATERIAL	~~SAND~~ silty MEDIUM TO FINE SAND, ~~<5% FINE~~ (SM) w/ GRAVEL AND SHELL FRAGMENTS, ~~<10% Non Plastic Fines~~, GRAY ~~(SP-SM)~~.
	24, 25	S-5A 2 JARS	2-0"	23.5 TO 25.0'	19, 31	APPROXIMATELY AT 23.5'. DROVE 3-0" CASING FROM 20.0 TO 23.0' AND WASHED OUT USING FISHTAIL BIT.	SILTY CLAY, ~~MODERATELY PLASTIC, <5%~~ PEAT & FIBERS INTERSPERSED, MODERATE DRY STRENGTH, MOTTLED GRAY AND BROWN, (CL).
	26				16, [illegible]6	DROVE 2-0" I.D. x 5' SOLID BARREL SAMPLER FROM 25.0 TO 30.0' USING 300 lb HAMMER DROPPED 18"	

Site: [illegible]	Boring No. [illegible] DESIG. G	Page [illegible] of 3

DEPTH		CORE/SAMPLE			BLOWS PER FT.	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
EVENT ON CASING	f=1.0'	NO.	SIZE	DEPTH RANGE	CORE REC'Y		
	28	S-6 2 JARS	2.0"	25.0 TO 30.0'	36	RECOVERED 30.0"	SILTY CLAY, ~~MODERATE PLASTICITY~~, <5% PEAT & FIBERS INTERSPERSED, MODERATE DRY STRENGTH, MOTTLED BROWNS, (CL).
	29				44		
					55		
	30					BOTTOM OF BORING 30.0'	

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FIELD LOG OF TEST BORING

Site [illegible] Page 1 of 3 Pages
Boring No. FD 82-3 Desig. E Diam. (Casing) 3-0"
Co-ordinates. N NOT GIVEN E. ______

Elevation Top of Boring	6.2' M.S.L.	Hammer Wt.	300 lb
Total Overburden Drilled	30.0' Feet	Hammer Drop	18"
Elevation Top of Rock	NONE ENCOUNTERED M.S.L.	Casing Left	NONE
Total Rock Drilled	-0- Feet	Subsurface Water Data	TIDAL Page ____
Elevation Bottom of Boring	-23.8' M.S.L.	Obs. Well	NO
Total Depth of Boring	30.0 Feet	Drilled By	BRIGGS ENGINEERING & TESTING. CO.
Core Recovered	N/A % No. Boxes —	Mfg. Des. Drill	ACKER
Core Recovered	N/A Ft: — Diam. — In.	Inspected By:	RONALD F. RUBACKI
Soil Samples	2-0 In. Diam. 10 No.	Classification By:	RONALD F. BUBACKI
Soil Samples	____ In. Diam. ____ No.	Classification By:	JPRazza MRD Lab 12 OCT 1982

Boring Started 8-25-82
Boring Completed 8-27-82

0700
0745 - ...
0915

DEPTH 1"=1.0'	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT. CORE REC'VY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
0–2	S-1 1 JAR	2-0"	0.0 TO 2.0'	3, 11	DROVE 2-0" I.D. x 5' SOLID BARREL SAMPLER FROM 0.0 TO 5.0' USING 300 lb HAMMER DROPPED 18".	SURFACE: BELOW SEA WALL ON SAND BEACH. SAND, ~~FINE MEDIUM TO~~ FINE SAND, ~~<2% NONPLASTIC FINES,~~ DAMP TO SATURATED, LIGHT GRAY, (SP).
2–5	S-1A 1 JAR	2-0"	2.0 TO 5.0'	26, 27, 31	RECOVERED 28-0". DROVE 3-0" CASING FROM 0.0 TO 5.0' AND WASHED OUT USING ROLLER ROCK BIT.	SILTY Sandy GRAVEL, COARSE TO FINE GRAVEL, ~~20-40% COARSE TO FINE SAND, <20% ... SLIGHTLY PLASTIC FINES,~~ SATURATED, LIGHT GRAYISH BROWN, ~~(GM)~~ (GP-GM)
5–6	S-2 1 of 2	2-0"	5.0 TO 6.0'	18	DROVE 2-0" I.D. x 5' SOLID BARREL SAMPLER FROM 5.0 TO 10.0' USING 300 lb HAMMER DROPPED 18".	LAYERED GRAVEL & SAND. GRAVEL, MEDIUM TO FINE SUBROUNDED GRAVEL, ~~25-35% COARSE TO FINE SAND, <5% NONPLASTIC FINES~~ Sandy Gravel GRAYISH BROWN, (GP).
6–10	S-2 2 of 2	2-0"	6.0 TO 10.0'	19, 21, 24, 26	RECOVERED 26-0". DROVE 3-0" CASING FROM 5.0 TO 10.0' AND WASHED OUT USING ROLLER ROCK BIT.	SAND ~~FINE MEDIUM TO~~ Silty FINE SAND, ~~<2% NONPLASTIC FINES,~~ GRAYISH BROWN, ~~(SP)~~ (SM)

8-25-82
RAIN

GENERAL REMARKS: BORING ELEVATIONS ARE REFERENCED TO EXISTING GROUND SURFACE ELEVATIONS.

Site: [illegible]	Boring No. [illegible] DESIG. E	Page 2 of 3

DEPTH: Blows on Casing	DEPTH: 1" = 1.0'	CORE/SAMPLE: No.	CORE/SAMPLE: Size	CORE/SAMPLE: Depth Range	Blows per ft. / Core Recvy	~~SAMPLING AND CORING~~ OPERATIONS	CLASSIFICATION OF MATERIALS
	11 12 13 14	S-3 1 JAR	2.0"	10.0 TO 15.0'	12 12 14 15 35	DROVE 2-0" I.D. x 5' SOLID BARREL SAMPLER FROM 10.0 TO 15.0' USING 300 lb HAMMER DROPPED 18". RECOVERED 13-0" DROVE 3-0" CASING FROM [illegible] 15.0' AND WASHED OUT USING SIDE DISCHARGING CHOPPING BIT.	silty fine SAND, ~~FINE MEDIUM TO FINE SAND, MOSTLY FINE SAND, < 5% NONPLASTIC FINES,~~ LIGHT GRAYISH BROWN, ~~(SP)~~ (SM)
	15 16 17 18 19	S-4 1 JAR	2.0"	15.0 TO 20.0'	6 6 9 12 15	DROVE 2-0" I.D. x 5' SOLID BARREL SAMPLER FROM 15.0 TO 20.0' USING 300 lb HAMMER DROPPED 18". RECOVERED 26-0" DROVE 3-0" CASING FROM 15.0 TO 20.0' AND WASHED OUT USING SIDE DISCHARGING CHOPPING BIT.	SAND WITH THIN LAYERS OF PEAT silty ~~SAND~~, FINE SAND, ~~5-10% NONPLASTIC FINES~~, GRAY (~~SP-SM~~) (SM) PEAT, FINE PEAT LAYERS < 1/8" THICK AT 8 TO 10", (Pt).
	20 21 22 23	S-5 1 JAR	2-0"	20.0 TO 23.5'	8 15 15 19	DROVE 2-0" I.D. x 5' SOLID BARREL SAMPLER FROM 20.0 TO 25.0' USING 300 lb HAMMER DROPPED 18". RECOVERED 23-0" DROVE 3-0" CASING FROM	silty fine SAND, ~~FINE MEDIUM TO FINE SAND, < 5% NONPLASTIC FINES~~, GRAY, ~~(SP)~~ (SP-SM)
	24	S-5A 1 JAR	2-0"	23.5 TO 25.0	23	20.0 TO 25.0' AND WASHED OUT USING SIDE DISCHARGE CHOPPING BIT.	SILTY CLAY, ~~MODERATE PLASTICITY, MODERATE DRY STRENGTH~~, GRAY, (CL).
	25 26 27				7 9	DROVE 2-0" I.D. x 5' SOLID BARREL SAMPLER FROM 25.0 TO 30.0' USING 300 lb HAMMER DROPPED 18-0".	

Site: REVERE, MA	Boring No. FD 82-3 DESIG. E	Page 3 of 3

DEPTH		CORE/SAMPLE			BLOWS PER FT. CORE RECV'Y	~~SAMPLING AND CORING~~ OPERATIONS	CLASSIFICATION OF MATERIALS
Blows on Casing	F = 1.0'	NO.	SIZE	DEPTH RANGE			
				25.0	10	RECOVERED 60-0".	SILTY CLAY, ~~MODERATE PLASTICITY~~, GREY, (CL).
	28	S-6 2 JARS	2-0"	TO			
				30.0'	11		
	29				13		
	30					BOTTOM OF BORING 30.0'	

2-9

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FIELD LOG OF TEST BORING

Site ______ Page 1 of 3 Pages

Boring No. FD 82-7 Desig. A Diam. (Casing) 3-0"

Co-ordinates. N NOT GIVEN E ______

Elevation Top of Boring 3.2' M.S.L.
Total Overburden Drilled 30.0 Feet
Elevation Top of Rock None Encountered M.S.L.
Total Rock Drilled — 0 — Feet
Elevation Bottom of Boring −26.8' M.S.L.
Total Depth of Boring 30.0' Feet
Core Recovered N/A % No. Boxes —
Core Recovered N/A Ft: — Diam. — in.
Soil Samples 2-0 In. Diam. 12 No.
Soil Samples ______ In. Diam. ______ No.

Hammer Wt. 300 lb Boring Started 8-27-82
Hammer Drop 18" Boring Completed 9-3-82
Casing Left none
Subsurface Water Data — Page —
TIDAL
Obs. Well no
Drilled By [illegible] Engineering & Testing Co.
Mfg. Des. Drill PTO Cathead - Truck Mount. Tripod
Inspected By: Ronald F. Bukoski
Classification By: Ronald F. Bukoski
Classification By: JPR Mat'ls Lab 12 Oct 1982

DEPTH 1"=10'	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT. / CORE REC'VY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
0–1				5	DROVE 2-0" I.D. X 5' SOLID BARREL SAMPLER FROM 0.0 TO 5.0' USING 300 lb HAMMER DROPPED 18".	SURFACE: BASE OF RIPRAP WALL, [illegible] ON SANDY BEACH. LAYERS OF GRAVELLY SAND AND SAND - MOSTLY GRAVELLY SAND.
1–2	S-1 2 JARS	2-0"	0.0 TO 5.0'	12	RECOVERED 21-0".	GRAVELLY c f SAND, ~~WELL GRADED COARSE TO FINE SAND, 20-30% MEDIUM TO FINE GRAVEL,~~ GRAYISH BROWN, (SW).
2–3				29	DROVE 3-0" CASING FROM 0.0 TO 5.0' AND WASHED OUT USING SIDE DISCHARGE CHOPPING BIT.	
3–4				48		m f sand (SP-SM) ~~SAND, MOSTLY FINE SAND, 5% NONPLASTIC FINES, LIGHT~~ GRAYISH BROWN, ~~(SP)~~.
4–5				47		
5–6			5.0	23	DROVE 2-0" I.D. X 5' SOLID BARREL SAMPLER FROM 5.0 TO 10.0' USING 300 lb HAMMER DROPPED 18".	GRAVELLY m f SAND, ~~15-20% MEDIUM TO FINE~~ SUBROUNDED GRAVEL, ~~MOSTLY FINE SAND, 5% NONPLASTIC FINES~~ LIGHT GRAYISH BROWN, (SP).
6–7	S-2 1 JAR	2-0"	TO 7.5'	13	RECOVERED 21-0".	
7–8	APPROXIMATE CHANGE IN MAT.			14		APPROXIMATE CHANGE IN MAT.
8–9	S-2A 1 JAR	2-0"	7.5 TO 10.0'	18	DROVE 3-0" CASING FROM 5.0 TO 10.0' AND WASHED OUT USING SIDE DISCHARGING CHOPPING BIT.	~~SAND, MOSTLY FINE SAND, 25% NONPLASTIC FINES,~~ silty f sand LIGHT GRAY AND BROWN, ~~(SP)~~. (SM)
9–10				18		

GENERAL REMARKS: BORING DEPTHS ARE REFERENCED TO EXISTING GROUND SURFACE.

Site: REVERE, MA	Boring No. FD 82-4 Desig. A	Page 2 of 3

Depth (ft)	Core/Sample No.	Size	Depth Range	Blows per ft / Core Recvy	Sampling and Coring Operations	Classification of Materials
10–15 (11, 12, 13, 14, 15)	S-3 1 JAR	2.0"	10.0 TO 15.0'	33, 20, 12, 19, 25	DROVE 2-0" I.D. SOLID BARREL SAMPLER FROM 10.0 TO 15.0' USING 300 lb HAMMER DROPPED 18". RECOVERED 24-0". DROVE 2-0" CASING FROM 10.0 TO 15.0' AND WASHED OUT USING SIDE DISCHARGE CHOPPING BIT.	m.f. Sand (SP-SM) ~~SAND, FINE MEDIUM TO FINE SAND, < 5% NON-PLASTIC FINES~~, GRAY, ~~(SP)~~.
15–18.5 (16, 17, 18)	S-4 1 JAR	2.0"	15.0 TO 18.5'	11, 8, 13, 22	DROVE 2-0" I.D. x 5' SOLID BARREL SAMPLER FROM 15.0 TO 20.0' USING A 300 lb HAMMER DROPPED 18". RECOVERED 27" APPROXIMATELY. DROVE 2-0" CASING FROM ~~15~~.0 TO ~~20~~.0' AND WASHED OUT USING SIDE DISCHARGE CHOPPING BIT.	SAND WITH GRAVEL LAYER ~~SAND, FINE MEDIUM TO~~ FINE SAND, ~~< 5% NONPLASTIC FINES~~, GRAY, ~~(SP)~~ (SP-SM) GRAVELLY SAND LAYER 15-25% MEDIUM TO FINE GRAVEL, MOSTLY FINE SAND, (SP).
18.5–20 (19, 20)	S-4A 2 JARS	2.0"	18.5 TO 20.0'	26		SILTY CLAY, ~~MODERATELY PLASTIC~~, GRAY, (CL).
20–25 (21, 22, 23, 24, 25)	S-5 2 JARS	2.0"	20.0 TO 25.0'	10, 10, 14, 15, 18	DROVE 2-0" I.D. SOLID BARREL SAMPLER FROM 20.0 TO 25.0' USING 300 lb HAMMER DROPPED 18". RECOVERED [illegible]" ON SECOND ATTEMPT. WASHED OUT HOLE USING SIDE DISCHARGE CHOPPING BIT	SILTY CLAY, ~~MODERATE PLASTICITY~~, GRAY, (CL).
25–27 (26, 27)				6, 6	DROVE 2-0" I.D. x 5' SOLID BARREL SAMPLER FROM 25 TO 30.0'	

8-29-82

Site: REVERE, MA	Boring No. FD 82-4 DESIG A	Page 3 of 3

DEPTH: Blows on Casing	DEPTH: Ft. /1.0'	CORE/SAMPLE: NO.	CORE/SAMPLE: SIZE	CORE/SAMPLE: DEPTH RANGE	BLOWS PER FT. / CORE RECV'Y	~~SAMPLING AND CORING~~ OPERATIONS	CLASSIFICATION OF MATERIALS
	28	S-6 2 JARS	2-0"	28.0 TO 30.0'	8 9 11	RECOVERED 37-0"	SILTY CLAY, ~~MODERATE PLASTICITY,~~ GRAY, ~~(CL)~~ (CH)
	29						
	30					BOTTOM OF BORING 30.0'	

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FIELD LOG OF TEST BORING

Site REVERE MA

Boring No. FD-82-5 Desig. C Diam. (Casing) 3-0"

Co-ordinates: N NOT GIVEN E

Elevation Top of Boring 3.0' M.S.L.
Total Overburden Drilled 30.0' Feet
Elevation Top of Rock NONE ENCOUNTERED M.S.L.
Total Rock Drilled —0— Feet
Elevation Bottom of Boring 27.0' M.S.L.
Total Depth of Boring 30.0' Feet
Core Recovered N/A % No. Boxes —
Core Recovered N/A Ft: — Diam. — In.
Soil Samples 2-0 In. Diam. 9 No.
Soil Samples In. Diam. No.

Hammer Wt. 300 lb Boring Started 8-30-82
Hammer Drop 18" Boring Completed 8-30-82
Casing Left NONE
Subsurface Water Data TIDAL Page —
Obs. Well NO
Drilled By BRIGGS ENGINEERING & TESTING CO.
Mfg. Des. Drill PTO-CATHEAD TRUCK MOUNT, TRIPOD
Inspected By: RONALD F. BUKOSKI
Classification By: RONALD F. BUKOSKI
Classification By: JPRazza Mat'ls Lab 12 Oct 1982

DEPTH 1"=1.0'	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT. / CORE REC'VY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
0–5	S-1 1 JAR	2-0"	0.0 TO 5.0'	12, 38, 47, 57, 75	DROVE 2-0" I.D. x 5' SOLID SPOON SAMPLER FROM 0.0 TO 5.0' USING 300 lb HAMMER DROPPED 18". RECOVERED 26-0". DROVE 3-0" CASING FROM 0.0 TO 5.0' AND WASHED OUT USING SIDE DISCHARGING CHOPPING BIT. MEDIUM TO FINE GRAVEL IN WASH.	SURFACE: GRAVELLY SAND BEACH. SANDY GRAVEL, MEDIUM TO FINE SUBROUNDED GRAVEL, ~~20-40% COARSE TO FINE SAND, <5% NONPLASTIC FINES~~, LIGHT GRAYISH BROWN, (GP).
5–10	S-2 1 JAR	2-0"	5.0 TO 10.0'	17, 20, 27, 24, 34	DROVE 2-0" I.D. x 5.0' SOLID SPOON SAMPLER FROM 5.0 TO 10.0' USING 300 lb HAMMER DROPPED 18". RECOVERED 27-0". DROVE 3-0" CASING FROM 5.0 TO 10.0' AND WASHED OUT USING SIDE DISCHARGE CHOPPING BIT.	silty fine SAND ~~FINE-MEDIUM TO FINE SAND, MOSTLY FINE SAND, <5% NONPLASTIC FINES~~, LIGHT GRAYISH BROWN, ~~(SP)~~ (SM)

GENERAL REMARKS: BORING DEPTHS ARE REFERENCED TO EXISTING GROUND SURFACE ELEVATION.

Site: Revere, MA	Boring No. FD 82-5 Test C	Page 2 of 3

Blows on Casing	Depth (Ft = 1.0')	Core/Sample No.	Size	Depth Range	Blows per Ft / Core Recvy	Sampling and Coring Operations	Classification of Materials
	11, 12, 13, 14	S-3 1 JAR	2.0"	10.0 to 15.0'	9, 10, 11, 17, 27	DROVE 2-0" I.D. x 5' SOLID SPOON SAMPLER FROM 10.0 TO 15.0' USING 300 lb HAMMER DROPPED 18". RECOVERED 39-0". DROVE 3-0" CASING FROM 10.0 TO 15.0' AND WASHED OUT USING SIDE DISCHARGE CHOPPING BIT.	SAND WITH THIN LAYERS OF PEAT. ~~SAND, MOSTLY FINE SAND, < 5% NONPLASTIC FINES~~, Silty fine GRAY, ~~(SP)~~. SM. PEAT, THIN LAYERS < 1/8" THICK AT ± 1" INTERVALS, (pt). SAND AT TIP OF SPOON SLIGHTLY COARSER WITHOUT PEAT.
	15, 16, 17	S-4 1 JAR	2.0"	15.0 to 18.0'	7, 16, 20	DROVE 2-0" I.D x 5' SOLID SPOON SAMPLER FROM 15.0 TO 20.0' USING 300 lb HAMMER DROPPED 18". RECOVERED 29-0".	SAND, MEDIUM TO FINE SAND, ~~< 5% NONPLASTIC FINES~~, LIGHT GRAY, (SP).
	18, 19	S-4A 1 JAR	2.0"	18.0 to 20.0'	27, 31	DROVE 3-0" CASING FROM 15.0 TO 20.0' AND WASHED OUT USING SIDE DISCHARGE CHOPPING BIT.	SILTY CLAY, ~~LOW TO MODERATE PLASTICITY~~, STIFF, BROWN WITH GRAY STREAKS, (CL)
	20, 21, 22, 23, 24	S-5 2 JARS	2.0"	20.0 to 25.0'	12, 14, 20, 21, 25	DROVE 2-0" I.D x 5' SOLID BARREL SAMPLER FROM 20.0 TO 25.0' USING 300 lb HAMMER DROPPED 18". NO RECOVERY 1ST ATTEMPT. RECOVERED 26-0". WASHED OUT HOLE FROM 20.0 TO 25.0' USING SIDE DISCHARGE CHOPPING BIT.	SILTY CLAY, ~~MODERATE PLASTICITY~~, STIFF, GRAY & BROWN STREAKS, ~~(CL)~~, (CH)
	25, 26, 27				6, 8	DROVE 2-0" I.D. SOLID BARREL SAMPLER FROM 25.0 TO 30.0' USING 300 lb HAMMER DROPPED 18"	

∇M

Site: REVERE, MA	Boring No. FD 82-5 DESIG. C	Page 3 of 3

Blows on Casing	Depth Ft. 1.0'	Core/Sample No.	Size	Depth Range	Blows per ft. Core Recv'y	~~Sampling and Coring~~ Operations	Classification of Materials
	28	S-6 2 JARS	2-0"	25.0 TO 30.0'	8	RECOVERED 34-0"	SILTY CLAY, ~~MODERATE PLASTICITY~~, STIFF, GRAY ~~(CL)~~ (CH) LESS STIFF THAN PREVIOUS SAMPLE
	29				11		
	30				13		
						BOTTOM OF BORING 30.0'	

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FIELD LOG OF TEST BORING

Site [illegible] Page 1 of 3 Pages

Boring No. FD 82-6 Desig. D Diam. (Casing) 3-0"

Co-ordinates. N NOT GIVEN E

Elevation Top of Boring 7.3' M.S.L.
Total Overburden Drilled 30.0 Feet
Elevation Top of Rock NONE ENCOUNTERED M.S.L.
Total Rock Drilled — 0 — Feet
Elevation Bottom of Boring 22.7' M.S.L.
Total Depth of Boring 30.0' Feet
Core Recovered N/A % No. Boxes —
Core Recovered N/A Ft : — Diam. — in.
Soil Samples 2-0 in. Diam. 6 No.
Soil Samples in. Diam. No.

Hammer Wt. 300 lb Boring Started 8-27-82
Hammer Drop 18" Boring Completed 8-31-82
Casing Left NONE
Subsurface Water Data Page
4.0' TIDAL
Obs. Well NO
Drilled By BRIGGS ENGINEERING & TESTING CO.
Mfg. Des. Drill PTO - CATHEAD, TRUCK MOUNT, TRIPOD
Inspected By: Ronald E. Purcell
Classification By: Ronald E. Purcell
Classification By: JPLuzza Mat'l Lab 12 Oct 1982

DEPTH 1"=1.0'	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT. CORE REC'VY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
0–1				9	DROVE 2-0" I.D x 5' SOLID SPOON SAMPLER FROM 0.0 TO 5.0' USING 300 lb HAMMER DROPPED 18".	SURFACE: SAND DUNE. SAND WITH GRAVELLY SAND LAYERS:
1–2			0.0	29		~~SAND, MOSTLY FINE SAND~~ ~~< 10% SHELL FRAGMENTS,~~ ~~< 5% NONPLASTIC FINES,~~ Gravelly m-f sand DRY TO MOIST, LIGHT GRAYISH BROWN, (SP).
2–3	S-1 1 JAR	2-0"	TO 5.0'	28	RECOVERED 16-0"	
3–4				26	DROVE 3-0" CASING FROM 0.0 TO 5.0' AND WASHED OUT USING SIDE DISCHARGE CHOPPING BIT.	GRAVELLY SAND, MEDIUM TO FINE GRAVEL, ~~MOSTLY FINE SAND, < 5% NONPLASTIC FINES~~, MOIST, LIGHT GRAYISH BROWN, (SP).
4–5				19		
5–6				11	DROVE 2-0" I.D x 5' SOLID SPOON SAMPLER FROM 5.0 TO 10.0 USING 300 lb HAMMER DROPPED 18".	
6–7			5.0	16		SAND, ~~< 5% MEDIUM TO FINE GRAVEL, MOSTLY FINE SAND TO 20%~~ med-fine sand FINE SHELL FRAGMENTS, LIGHT GRAYISH BROWN, ~~(SP)~~ (SP-SM)
7–8	S-2 1 JAR	2-0"	TO 10.0'	33	RECOVERED 17-0"	
8–9				40	DROVE 3-0" CASING FROM 5.0 TO 10.0' AND WASHED OUT USING SIDE DISCHARGE CHOPPING BIT.	
9–10				39		

GENERAL REMARKS:

Site: REVERE, MA

Boring No. FD 82-6
DESIG. D

Blows on Casing	Depth ft 1.0'	Core/Sample No.	Size	Depth Range	Blows per 6" / Core Recvy	Sampling and Coring Operations	Classification of Materials
	10–11	S-3 1 JAR	2-0"	10.0 TO 15.0'	14	DROVE 2-0" I.D. x 5' SOLID SPOON SAMPLER FROM 10.0 TO 15.0' USING 300 lb HAMMER DROPPED 18". RECOVERED 16-0". DROVE 3-0" CASING FROM 10.0 TO 15.0' AND WASHED OUT USING CHOPPING BIT.	Silty GRAVELLY SAND, (SM) ~~10-15%~~ COARSE TO FINE SUBROUNDED GRAVEL, ~~MOSTLY FINE SAND, 10-15%~~ SHELL FRAGMENTS, ~~<5% NONPLASTIC FINES,~~ GRAY, ~~(SP).~~
	11–12				23		
	12–13				34		
	13–14				43		
	14–15				44		
6-21-82	15–16	S-4 1 JAR	2-0"	15.0 TO 20.0'	19	DROVE 2-0" I.D. x 5' SOLID SPOON SAMPLER FROM 15.0 TO 20.0' USING 300 lb HAMMER DROPPED 18". RECOVERED 29-0". DROVE 3-0" CASING FROM 15.0 TO 20.0' AND WASHED OUT USING SIDE DISCHARGE CHOPPING BIT.	Silty fine sand (SM) ~~SAND, FINE MEDIUM TO FINE SAND, MOSTLY FINE SAND, <5%~~ shell FRAGMENTS, ~~<5% NONPLASTIC FINES, <5% FINE~~ SUBROUNDED GRAVEL, GRAY, (SP).
	16–17				18		
	17–18				30		
	18–19				33		
	19–20				45		
	20–21	S-5 1 JAR	2-0"	20.0 TO 25.0'	10	DROVE 2-0" I.D SOLID SPOON SAMPLER FROM 20.0 TO 25.0' USING 300 lb HAMMER DROPPED 18". RECOVERED 26-0". DROVE 3-0" CASING FROM 20.0 TO 25.0' AND WASHED OUT USING SIDE DISCHARGE CHOPPING BIT.	SAND WITH THIN LAYERS OF PEAT ~~SAND, FINE MEDIUM TO FINE SAND, <5% NONPLASTIC~~ Silty f sand ~~FINES~~, GRAY, ~~(SP)~~ SM. PEAT, THIN LAYERS < 1/16" AT RANDOM INTERVALS APPROXIMATELY 2/inch, MODERATE ORGANIC ODOR, BROWN, (Pt).
	21–22				16		
	22–23				23		
	23–24				29		
	24–25				31		
	25–26				12	DROVE 2-0" I.D. x 5' SOLID SPOON SAMPLER FROM 25.0 TO 30.0' USING 300 lb HAMMER DROPPED 18".	
	26–27				14		

DEPTH		CORE/SAMPLE			BLOWS PER FT. CORE RECV'Y	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
BLOWS ON CASING	F = 1.0'	NO.	SIZE	DEPTH RANGE			
					25	RECOVERED 27-0"	SAND WITH THIN PEAT LAYERS ~~SAND, MEDIUM TO FINE SAND,~~ Silty m f sand (SM) ~~<10%~~ SHELL FRAGMENTS, ~~<5% NONPLASTIC FINES,~~ GRAY, ~~(SP)~~. PEAT, THIN LAYERS < 1/16" INTERSPERSED BETWEEN 1/2 TO 1" SAND LAYERS, MODERATE ORGANIC ODOR, BROWN, (PT).
	28	S-6 1 JAR	2-0"	25.0 TO 30.0'	26		
	29				38		
	30					BOTTOM OF BORING 30.0'	

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FIELD LOG OF TEST BORING

Site REVERE MA Page 1 of 3 Pages
Boring No. FD 82-7 Desig. H Diam. (Casing) 3-0"
Co-ordinates. N NOT GIVEN E

Elevation Top of Boring 6.5' M.S.L.
Total Overburden Drilled 30.0' Feet
Elevation Top of Rock NONE ENCOUNTERED M.S.L.
Total Rock Drilled —0— Feet
Elevation Bottom of Boring 23.5' M.S.L.
Total Depth of Boring 30.0 Feet
Core Recovered N/A % No. Boxes —
Core Recovered N/A Ft: — Diam. — In.
Soil Samples 2-0 In. Diam. 7 No.
Soil Samples 1-3/8 In. Diam. 1 No.

Hammer Wt. 300 lb
Hammer Drop 18"
Casing Left NONE
Subsurface Water Data — Page —
Obs. Well NO TIDAL
Drilled By BRIGGS ENGINEERING & TESTING Co.
Mfg. Des. Drill PTO-CATHEAD, TRUCK MOUNT, TRIPOD
Inspected By: RONALD F. BUKOSKI
Classification By: RONALD F. BUKOSKI
Classification By: J P Razza Mat'ls Lab 12 Oct 1982
Boring Started 8-31-82
Boring Completed 8-31-82

DEPTH 1"=1.0'	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT. / CORE REC'VY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
0–1	S-1 1 JAR	2-0"	0.0 TO 1.0'	9	DROVE 2-0" I.D. x 5' SOLID SPOON SAMPLER FROM 0.0 TO 5.0' USING 300 lb HAMMER DROPPED 18". RECOVERED 23-0"	SURFACE: SAND DUNE ABOVE HIGH WATER LINE. ~~SAND, MOSTLY~~ FINE SAND, ~~<5% NONPLASTIC FINES,~~ DRY TO MOIST, VERY LIGHT GRAYISH BROWN, (SP).
1–2				13		
2–3	S-1A 1 JAR	2-0"	1.0 TO 5.0'	25	DROVE 3-0" CASING FROM 0.0 TO 5.0' AND WASHED OUT USING SIDE DISCHARGE CHOPPING BIT.	SANDY GRAVEL, MEDIUM TO FINE SUBROUNDED GRAVEL, ~~30-40% COARSE TO FINE SAND, <5% NONPLASTIC FINES,~~ MOIST TO SATURATED AT 4.5', BROWN, (GP).
3–4				22		
4–5				23		
5–6	S-2 1 JAR	2-0"	5.0 TO 10.0'	21	DROVE 2-0" I.D. x 5' SOLID SPOON SAMPLER FROM 5.0 TO 10.0' USING 300 lb HAMMER DROPPED 18". RECOVERED 18"	~~SANDY GRAVEL,~~ MEDIUM TO FINE SUBROUNDED GRAVEL, ~~30-35% COARSE TO FINE SAND, <5% NON-PLASTIC FINES,~~ Gravelly C.-f. Sand (SP-SM) BROWN, (GP).
6–7				24		
7–8				28	DROVE 3-0" CASING FROM 5.0 TO 10.0' AND WASHED OUT USING SIDE DISCHARGE CHOPPING BIT.	
8–9				25		
9–10				19		

GENERAL REMARKS: BORING DEPTHS ARE REFERENCED TO THE EXISTING GROUND SURFACE.

NED 1.55(Test) Boring No. FD 82-7 DESIG H

Site: REVERE, MA	Boring No. FD 82-7 Desig H	Page 2 of 3

DEPTH: Blows on Casing	DEPTH: Ft = 1.0'	CORE/SAMPLE: No.	CORE/SAMPLE: Size	CORE/SAMPLE: Depth Range	BLOWS PER FT. / CORE RECV'Y	~~SAMPLING AND CORING~~ OPERATIONS	CLASSIFICATION OF MATERIALS
	10–15 (11, 12, 13, 14, 15)	S-3 1 JAR	2-0"	10.0 TO 15.0'	9, 9, 10, 11, 12	DROVE 2-0" I.D. x 5' SOLID SPOON SAMPLER FROM 10.0 TO 15.0' USING 300 lb HAMMER DROPPED 18". RECOVERED 27-0". DROVE 3-0" CASING FROM 10.0 TO 15.0' AND WASHED OUT USING SIDE DISCHARGE CHOPPING BIT	SAND WITH THIN LAYERS OF PEAT. ~~SAND, FINE MEDIUM TO FINE SAND, < 5% NONPLASTIC FINES~~ Silty fine sand, GRAY, ~~(SP)~~ (SM). PEAT, THIN LAYERS < 1/16" THICK, APPROXIMATELY 1/2 TO 1" BETWEEN LAYERS, MODERATE ORGANIC ODOR, BROWN, (Pt).
	15–20 (16, 17, 18, 19, 20)	S-4 1 JAR	2-0"	15.0 TO 20.0'	3, 4, 7, 12, 17	DROVE 2-0" I.D x 5' SOLID SPOON SAMPLER FROM 15.0 TO 20.0' USING 300 lb HAMMER DROPPED 18". RECOVERED 30-0". DROVE 3-0" CASING FROM 15.0 TO 20.0' AND WASHED OUT USING SIDE DISCHARGE CHOPPING BIT.	SAND WITH THIN LAYERS OF PEAT, ~~SAME AS SAMPLE S-3~~ Gr. silty f sand (SM)
	20–22.75 (21, 22)	S-5 1 JAR	2-0"	20.0 TO 22.75'	4, 4, 11	DROVE 2-0" I.D. x 5' SOLID SPOON SAMPLER FROM 20.0 TO 25.0' USING 300 lb HAMMER DROPPED 18". RECOVERED 32-0"	~~SAND~~ Gravelly MEDIUM TO FINE SAND, ~~< 5% NONPLASTIC FINES, 5-10%~~ SHELL FRAGMENTS, ~~< 5%~~ INTERSPERSED PEAT, GRAY (SP).
	22.75–25 (23, 24, 25)	S-5A 1 JAR	2-0"	22.75 TO 25.0'	16, 21	DROVE 3-0" CASING FROM 20.0 TO 25.0' AND WASHED OUT USING SIDE DISCHARGE CHOPPING BIT.	SILTY CLAY, ~~MODERATE PLASTICITY~~, STIFF, MOTTLED BROWN AND GRAY, (CL).
	25–27 (26, 27)				13, 24	DROVE 2-0" I.D. x 5' SOLID SPOON SAMPLER FROM 25.0 TO 30.0' USING 300 lb HAMMER DROPPED 18".	

Site: REVERE,	Boring No. FD 82-7 DESIG. H	Page 3 of 3

DEPTH		CORE/SAMPLE			BLOWS PER FT. / CORE RECV'Y	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
Blows on Casing	F = 1.0'	NO.	SIZE	DEPTH RANGE			
	28	S-6 1 JAR	1-3/8"	25.0 TO 30.0'	37	NO RECOVERY IN TWO ATTEMPTS USING 2-0" I.D SAMPLER.	SILTY CLAY, ~~MODERATE PLASTICITY~~, STIFF +, MOTTLED GRAY AND BROWN (CL)
	29				58	DROVE 1-3/8" I.D. SPLIT-BARREL SAMPLER FOR RECOVERY. RECOVERED 18" :	
	30				78		
						BOTTOM OF BORING 30.0'	

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FIELD LOG OF TEST BORING

Site [illegible] Page 1 of 3 Pages
Boring No. [illegible] Desig. [illegible] Diam. (Casing) [illegible]
Co-ordinates. N [illegible] E

Elevation Top of Boring 28' M.S.L.
Total Overburden Drilled 30.0 Feet
Elevation Top of Rock NONE ENCOUNTERED M.S.L.
Total Rock Drilled -0- Feet
Elevation Bottom of Boring 27.2 M.S.L.
Total Depth of Boring 30.0 Feet
Core Recovered N/A % No. Boxes —
Core Recovered N/A Ft: — Diam. — In.
Soil Samples 2-0 In. Diam. 8 No.
Soil Samples In. Diam. No.

Hammer Wt. 300 lb Boring Started 9-3-82
Hammer Drop 18" Boring Completed 9-3-82
Casing Left NONE
Subsurface Water Data TIDAL Page
Obs. Well [illegible]
Drilled By [illegible] ENGINEERING [illegible]
Mfg. Des. Drill PTO-CATHEAD TRUCK MOUNT TRIPOD
Inspected By: [illegible]
Classification By: [illegible]
Classification By: JMazza mat'l lab 12 Oct 1982

DEPTH 1"=1.0'	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT. / CORE REC'VY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
0–1	S-1 1 JAR	2-0"	0.0 TO 2.0'	13	DROVE 2-0" I.D. X 5' SOLID SPOON SAMPLER FROM 0.0 TO 5.0' USING 300 lb HAMMER DROPPED 18".	SURFACE: SAND
1–2				15	RECOVERED 27-0"	SAND AND SHELL FRAGMENTS ~~COARSE TO FINE SAND, [illegible]~~ MEDIUM TO FINE ~~[illegible]~~ Sand SHELL FRAGMENTS, ~~[illegible]~~ ~~[illegible]~~, [illegible] BROWN ~~(SW)~~ (SP-SM)
2–3	S-1A 1 JAR	2-0"	2.0 TO 5.0'	12	DROVE 3-0" CASING FROM 0.0 TO 5.0' AND WASHED OUT USING SIDE DISCHARGE CHOPPING BIT.	~~SAND, [illegible]~~ ~~[illegible]~~ Silty FINE Sand, ~~[illegible]~~ ~~[illegible]~~, THIN SEAMS OF FINE [illegible], BROWN, ~~(SP)~~ (SM)
3–4				16		
4–5				18		
5–6	S-2 1 JAR	2-0"	5.0 TO 10.0'	8	DROVE 2-0" I.D. X 5' SOLID SPOON SAMPLER FROM 5.0 TO 10.0' USING 300 lb HAMMER DROPPED 18".	~~SAND, [illegible]~~ ~~[illegible]~~
6–7				11		Silty FINE SAND, ~~[illegible]~~ ~~FINES~~, GRAY, ~~(SP)~~ (SM)
7–8				16	RECOVERED 36-1/2"	
8–9				22	DROVE 3-0" CASING FROM 5.0 TO 10.0' AND WASHED OUT USING SIDE DISCHARGE CHOPPING BIT.	
9–10				33		

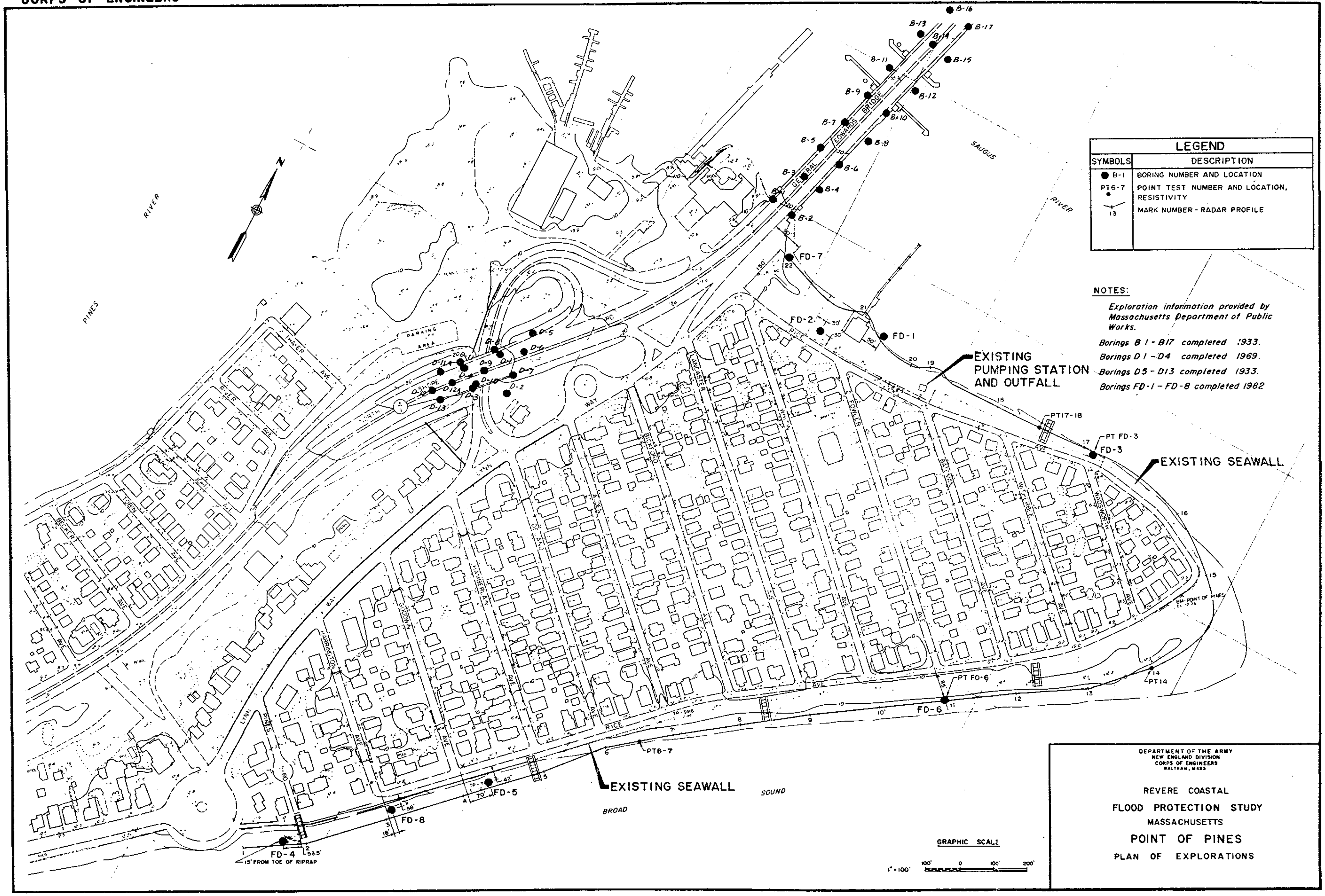
GENERAL REMARKS: BORING DEPTHS ARE REF. TO EXISTING GROUND SURFACE ELEVATIONS

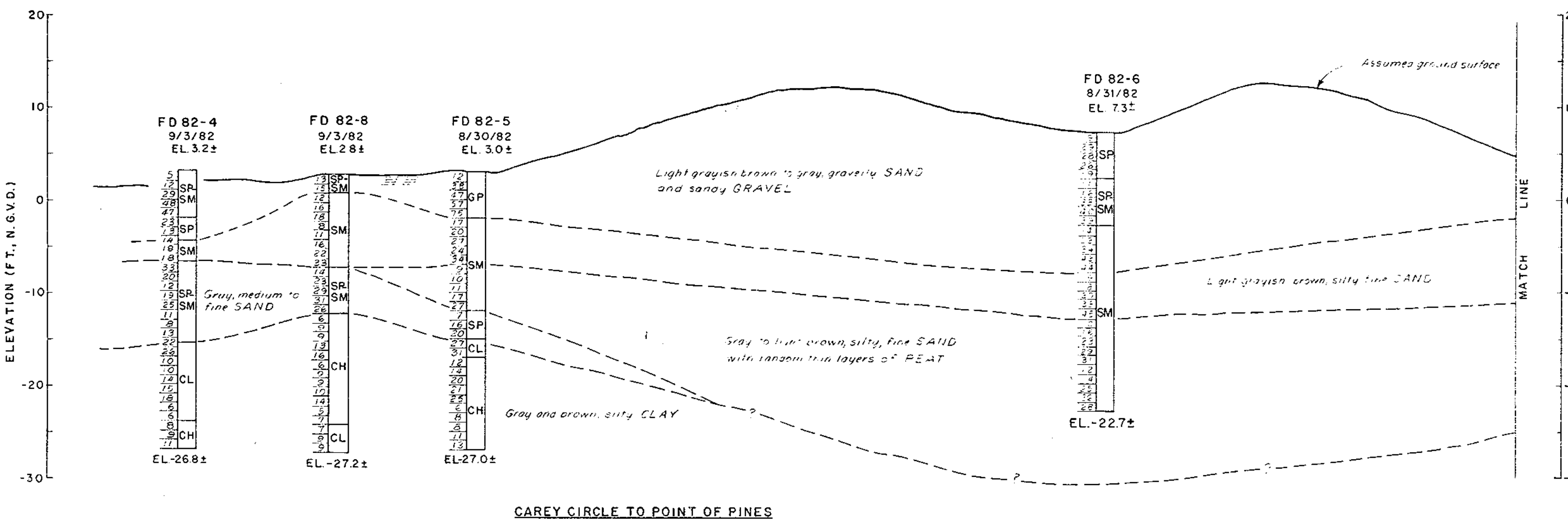
Site: REVERE, MA	Boring No. FD 82-6 DESIG. B	Page 2 of 3

DEPTH: Blows on Casing	DEPTH: Ft. 1.0	CORE/SAMPLE: NO.	CORE/SAMPLE: SIZE	CORE/SAMPLE: DEPTH RANGE	BLOWS PER FT. / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
	11, 12, 13, 14	S-3 1 JAR	2-0"	10.0 TO 15.0'	14, 23, 29, 31, 26	DROVE 2-0" I.D. x 5' SOLID SPOON SAMPLER FROM 10.0 TO 15.0' USING 300 lb HAMMER DROPPED 18" RECOVERED 18-0" DROVE 3-0" CASING FROM 10.0 TO 15.0' AND WASHED OUT USING SIDE DISCHARGE CHOPPING BIT.	Gravelly ~~SAND,~~ MEDIUM TO FINE SAND, ~~LESS MODERATE FINES,~~ GRAY, ~~(SP)~~ (SP-SM) GRADATION SLIGHTLY FINER AT THE TOP OF RECOVERED SAMPLE.
	15, 16, 17, 18, 19	NO RECOVERY			6, 9, 9, [illegible], 14	DROVE 2-0" I.D. x 5' SOLID SPOON SAMPLER FROM 15.0 TO 20.0' USING 300 lb HAMMER DROPPED 18" NO RECOVERY - CASING DRIVEN BEFORE NO RECOVERY WAS DISCOVERED. DROVE 3-0" CASING FROM 15.0 TO 20.0' AND WASHED OUT USING SIDE DISCHARGE CHOPPING BIT.	SILTY CLAY IN WASH AT 15.0'
	20, 21, 22, 23, 24	S-4 2 JARS	2-0"	20.0 TO 25.0'	6, 7, 9, 13, 14	DROVE 2-0" I.D. x 5' SOLID SPOON SAMPLER FROM 20.0 TO 25.0' USING 300 lb HAMMER DROPPED 18". RECOVERED 24" WASHED AND DRIVEN CASING FROM 20.0 TO 25.0' USING SIDE DISCHARGE CHOPPING BIT.	SILTY CLAY, ~~MODERATE PLASTICITY~~, GRAY, ~~(CL)~~ (CH)
	25, 26, 27				5, 7	DROVE 2-0" I.D. x 5' SOLID BARREL SAMPLER FROM 25.0 TO 30.0' USING 300 lb HAMMER DROPPED 18".	

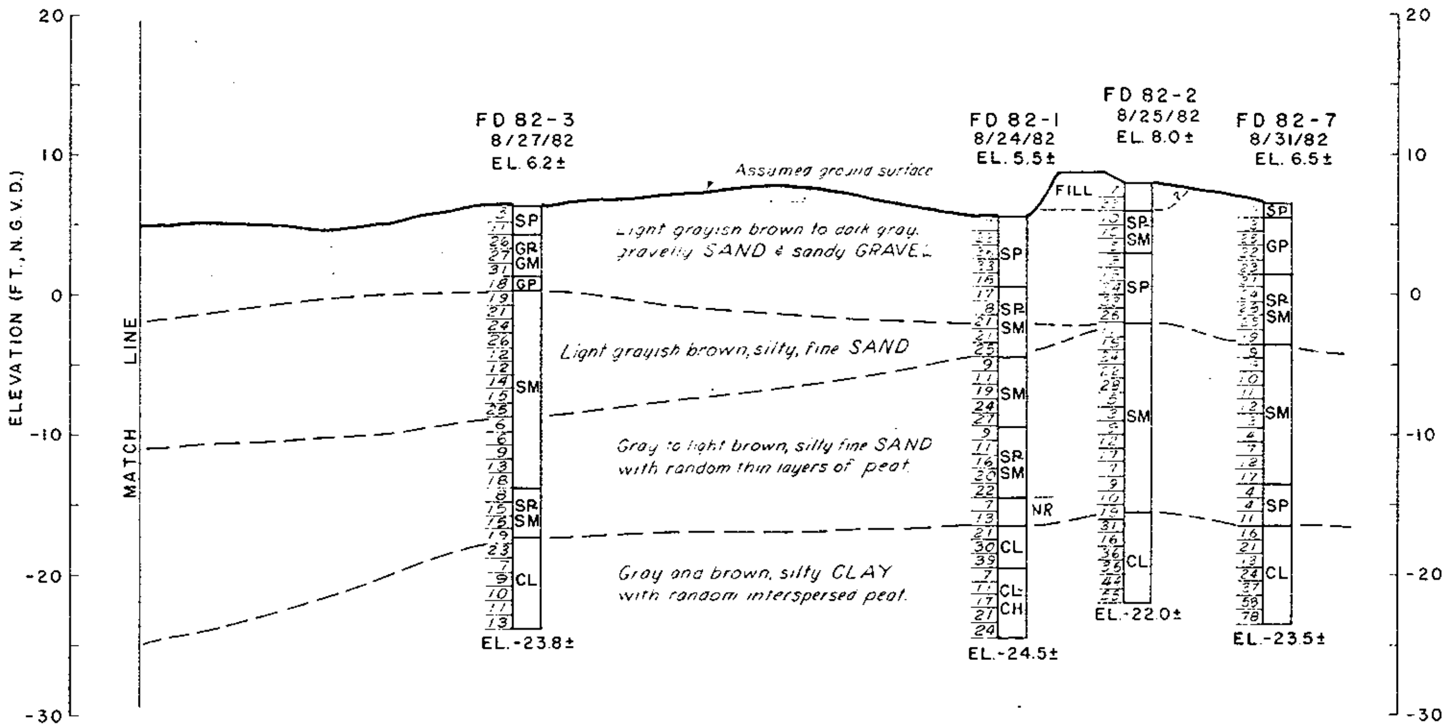
Site: REVERE, MA	Boring No. FD 82-6 DESIG. B	Page 3 of 3

DEPTH: Blows on Casing	DEPTH: Ft.	CORE/SAMPLE: NO.	CORE/SAMPLE: SIZE	CORE/SAMPLE: DEPTH RANGE	BLOWS PER FT. / CORE RECV'Y	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
	28	S-5 2 JARS	2.0"	28.0 TO 30.0'	7	RECOVERED	SILTY CLAY, ~~MODERATE PLASTICITY,~~ GRAY, (CL).
	29				9		
	30				9		
						BOTTOM OF BORING 30.0'	


LEGEND
SYMBOLS
DESCRIPTION
B-1 BORING NUMBER AND LOCATION
PT6-7 POINT TEST NUMBER AND LOCATION, RESISTIVITY
13 MARK NUMBER - RADAR PROFILE
NOTES:
Exploration information provided by Massachusetts Department of Public Works.
Borings B 1 - B17 completed 1933.
Borings D 1 - D4 completed 1969.
Borings D5 - D13 completed 1933.
Borings FD-1 - FD-8 completed 1982
EXISTING PUMPING STATION AND OUTFALL
EXISTING SEAWALL
EXISTING SEAWALL
GENERAL EDWARDS BRIDGE
SAUGUS RIVER
PINES RIVER
BROAD SOUND
FD-1
FD-2
FD-3
FD-4
FD-5
FD-6
FD-7
FD-8
PT FD-3
PT FD-6
PT6-7
PT14
PT17-18
15' FROM TOE OF RIPRAP
GRAPHIC SCALE
1" = 100'
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS
REVERE COASTAL
FLOOD PROTECTION STUDY
MASSACHUSETTS
POINT OF PINES
PLAN OF EXPLORATIONS



CAREY CIRCLE TO POINT OF PINES



POINT OF PINES TO NORTH SHORE ROAD

GEOLOGIC LOG PROFILE

SCALE: HOR. 1"=100' VERT. 1"=5'

LEGEND FOR GRAPHIC LOGS

FD 82-6	Type and number of exploration
8/30/82	Date exploration made
EL. 3.0±	Elevation of ground surface (Ft., N.G.V.D.) at time of exploration
SP	Group letter symbol according to the Unified Soil Classification System
27	Number of blows per foot of penetration using a 300 lb. hammer falling freely an average drop of 18 inches to drive a sample spoon of 2 inch I.D. in size, equipped with a bevelled and sharpened drive shoe
NR	No sample recovered
EL. -27.0±	Elevation at bottom of exploration (Ft., N.G.V.D.)
	Assumed ground surface
?	Assumed material boundary. Where a greater degree of uncertainty exists

NOTES

1. Elevations are based on the N.G.V.D. datum = 4.59 feet above M.L.W.
2. View of profiles is onshore

GRAPHIC SCALES

1" = 5' 5 0 5 10

1" = 100' 100 0 100 200

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

E.B. DES BY

J.B.M. DR BY

CK BY

REVERE COASTAL FLOOD PROTECTION STUDY

POINT OF PINES, REVERE, MA.

GEOLOGIC LOG PROFILES

GEOTECH. ENG. BR

PLATE B-2

SCALE: AS NOTED

DATE

APPENDIX C

DESIGN AND COST ESTIMATES

CONSTRUCTION COST ESTIMATE	DATE PREPARED 19 Sept 1984	SHEET 1 OF 1

PROJECT: POINT OF PINES EL. 15.0 NGVD

LOCATION: REVERE MA

ARCHITECT ENGINEER

BASIS FOR ESTIMATE
- [ ] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.

ESTIMATOR: O'LEARY

CHECKED BY

SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
Site Prep	1	Job			LS		10,000
Mob/Demob	1	Job			LS		25,000
Excavation	36,700	CY			20.–	–	734,000
Gravel Bedding	8,700	CY			10.–	–	87,000
Underlayer Stone	15,400	CY			25.–	–	385,000
Armor Stone	28,400	CY			30.–	–	852,000
Sandfill (VF)	8,500	CY			8.–	–	68,000
Sandfill (BF)	20,600	CY			8.–	–	164,800
Dune Sand	6,700	CY			8.–		53,600
Beach Grass	13,200	EA			1.–		13,200
Snow Fence	1,700	LF			3.–		5,100
Beach Access	14	EA			7,000.–	–	98,000
Topsoil, seeded	1,900	SY			1.50		2,850
Pre Cast Conc. Wall	760	LF			85.–	–	64,600
Pre Cast Conc. Wall	960	LF			90.–		86,400
6' Chain Link Fence	500	LF			14.–		7,000
Pump. Station	1	Job			LS		150,000
Sand bags	280	EA			5.–		1,400
							2,807,950
				Contingencies			692,050
					→	#	3,500,000

ENG FORM 150, 1 AUG 59 — PREVIOUS EDITION MAY BE USED — U.S. GOVERNMENT PRINTING OFFICE: 1959 O—514146

CONSTRUCTION COST ESTIMATE	DATE PREPARED 19 Sept. 1984	SHEET 1 OF 3

PROJECT: POINT OF PINES EL. 15.0 NGVD

LOCATION: REVERE MA

~~ARCHITECT~~ ENGINEER: TORNIFOGLIO / O'LEARY

DRAWING NO.: N/A

ESTIMATOR: O'LEARY

CHECKED BY:

BASIS FOR ESTIMATE:
- [ ] CODE A (No design completed)
- [x] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
ESTIMATE by REACH							
REACH A							
Excavation	4600	CY			20.–		92,000
Gravel Bedding	800	CY			10.–		8,000
Under layer Stone	2400	CY			25.–		60,000
Armor Stone	4600	CY			30.–		138,000
Sandfill (VF)	1500	CY			8.–		12,000
Sandfill (BF)	5200	CY			8.–		41,600
Beach Access	2	EA			7,000.–		14,000
							(365,600)
REACH B							
Excavation	8400	CY			20.–		168,000
Gravel Bedding	1600	CY			10.–		16,000
Under layer Stone	5200	CY			25.–		130,000
Armor Stone	8200	CY			30.–		246,000
Sandfill (VF)	2500	CY			8.–		20,000
Sandfill (BF)	8000	CY			8.–		64,000
Beach Access	1	EA			7,000.–		7,000
							(651,000)
REACH C							
Excavation	7900	CY			20.–		158,000
Gravel Bedding	1200	CY			10.–		12,000
Underlayer Stone	3700	CY			25.–		92,500
Armor Stone	7400	CY			30.–		222,000
Sandfill (VF)	2000	CY			8.–		16,000
Sandfill (BF)	6500	CY			8.–		52,000
Beach Access	2	EA			7,000.–		14,000
							(566,500)

ENG FORM 150
1 AUG 59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE	DATE PREPARED	SHEET 2 OF 3

PROJECT: POINT OF PINES EL. 15.0' NGVD

LOCATION:

ARCHITECT ENGINEER:

BASIS FOR ESTIMATE:
- [ ] CODE A (No design completed)
- [x] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.: | ESTIMATOR: O'LEARY | CHECKED BY:

SUMMARY	QUANTITY: NO. UNITS	QUANTITY: UNIT MEAS.	LABOR: PER UNIT	LABOR: TOTAL	MATERIAL: PER UNIT	MATERIAL: TOTAL	TOTAL COST
REACH D							
Excavation	13,900	CY			20.–		278,000
Gravel Bedding	1400	CY			10.–		14,000
Underlayer Stone	4100	CY			25.–		102,500
Armor Stone	8200	CY			30.–		246,000
Sandfill (VF)	2500	CY			8.–		20,000
Sandfill (BF)	700	CY			8.–		5,600
Beach Access	2	EA			7,000.–		14,000
							(680,100)
REACH E							
Sand	6700	CY			8.–		53,600
Beach Grass	13,200	EA			1.–		13,200
Snow Fence	1.700	LF			3.–		5,100
Beach Access	7	EA			7,000.–		49,000
							(120,900)
REACH F							
Excavation	600	CY			20.–		12,000
Gravel Bedding	2900	CY			10.–		29,000
Topsoil seeded	1100	SY			1.50		1,650
Conc. Ret. Wall	960	LF			90.–		86,400
							(129,050)

ENG FORM 150
1 AUG 59

PREVIOUS EDITION MAY BE USED

* U.S. GOVERNMENT PRINTING OFFICE 1959 O—516148

CONSTRUCTION COST ESTIMATE

DATE PREPARED

SHEET 3 OF 3

PROJECT: POINT OF PINES EL. 15.0 NGVD

LOCATION

ARCHITECT ENGINEER

BASIS FOR ESTIMATE

- [ ] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.

ESTIMATOR: O'LEARY

CHECKED BY

SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
REACH G							
Excavation	1300	CY			20.–		26,000
Gravel Bedding	800	CY			10.–		8,000
Sandfill (BF)	200	CY			8.–		1,600
Topsoil, seeded	800	SY			1.50		1,200
Sand bags	280	EA			5.–		1,400
Conc. Ret. Wall	760	LF			85.–		64,600
6' Chain link Fence	500	LF			14.–		7,000
(2-10'x6' gates)							(109,800)
SUMMARY							
REACH A							365,600
B							651,000
C							566,500
D							680,100
E							120,900
F							129,050
G							109,800
				sub-total			2,622,950
Pump Sta (Grav.)	1	Job			L.S.		150,000
Site Prep.	1	Job			L.S.		10,000
Mob/Demob.	1	Job			L.S.		25,000
							2,807,950
				contingencies			692,050
							3,500,000

ENG FORM 150
1 AUG 59

PREVIOUS EDITION MAY BE USED

* U.S. GOVERNMENT PRINTING OFFICE : 1959 O—516146

CONSTRUCTION COST ESTIMATE

DATE PREPARED: 20 Sept. 1984 | SHEET 1 OF 1

PROJECT: POINT OF PINES EL. 16.5' NGVD

LOCATION: REVERE MA.

ARCHITECT ENGINEER:

BASIS FOR ESTIMATE:
- [ ] CODE A (No design completed)
- [x] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.:

ESTIMATOR: O'LEARY

CHECKED BY:

SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Site Prep	1	Job			LS	—	10,000
Mob/Demob	1	Job			LS	—	25,000
Excavation	37,900	CY			20.—	—	758,000
Gravel Bedding	8,950	CY			10.—	—	89,500
Underlayer Stone	16,000	CY			25.—	—	400,000
Armor Stone	29,300	CY			30.—	—	879,000
Sandfill (VF)	8,800	CY			8.—	—	70,400
Sandfill (BF)	21,250	CY			8.—	—	170,000
Dune Sand	6,700	CY			8.—	—	53,600
Beach Grass	13,200	EA			1.—	—	13,200
Snow Fence	1,700	LF			3.—	—	5,100
Beach Access	14	EA			7,000.—		98,000
Topsoil, Seeded	1900	SY			1.50	—	2,850
Pre Cast Conc. Wall	760	LF			85.—	—	64,600
Pre Cast Conc. Wall	960	LF			90.—	—	86,400
6' Chain Link Fence	500	LF			14.—	—	7,000
Pump. Station	1	Job			L.S.	—	150,000
Sandbags	280	EA			5.—	—	1,400
							2,884,050
				Contingencies			715,950
				→		$	3,600,000

ENG FORM 150
1 AUG 59

PREVIOUS EDITION MAY BE USED

* U.S. GOVERNMENT PRINTING OFFICE : 1959 O—510146

CONSTRUCTION COST ESTIMATE

DATE PREPARED	SHEET
20 Sept 1984	1 OF 3

PROJECT: POINT OF PINES EL. 16.5' NGVD

LOCATION: REVERE MA.

ARCHITECT ENGINEER: Tornifoglio / O'Leary

DRAWING NO.: N/A

ESTIMATOR: O'LEARY

CHECKED BY:

BASIS FOR ESTIMATE

- [ ] CODE A (No design completed)
- [x] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
ESTIMATE by REACH							
REACH A							
Excavation	4600	CY			20.–		92,000
Gravel Bedding	800	CY			10.–		8,000
Underlayer Stone	2400	CY			25.–		60,000
Armor Stone	4600	CY			30.–		138,000
Sandfill (VF)	1500	CY			8.–		12,000
Sandfill (BF)	5200	CY			8.–		41,600
Beach Access	2	EA			7,000.–		14,000
							(365,600)
REACH B							
Excavation	8700	CY			20.–		174,000
Gravel Bedding	1700	CY			10.–		17,000
Underlayer Stone	5400	CY			25.–		135,000
Armor Stone	8500	CY			30.–		255,000
Sandfill (VF)	2600	CY			8.–		20,800
Sandfill (BF)	8300	CY			8.–		66,400
Beach Access	1	EA			7,000.–		7,000
							(675,200)
REACH C							
Excavation	8200	CY			20.–		164,000
Gravel Bedding	1300	CY			10.–		13,000
Underlayer Stone	3900	CY			25.–		97,500
Armor Stone	7700	CY			30.–		231,000
Sandfill (V.F)	2100	CY			8.–		16,800
Sandfill (BF)	6800	CY			8.–		54,400
Beach Access	2	EA			7,000.–		14,000
							(590,700)

CONSTRUCTION COST ESTIMATE	DATE PREPARED 20 Sept 1984	SHEET 2 OF 3
PROJECT Point of Pines EL. 16.5' NGVD		BASIS FOR ESTIMATE
LOCATION		☐ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify)
ARCHITECT ENGINEER		
DRAWING NO.	ESTIMATOR O'LEARY	CHECKED BY

SUMMARY	QUANTITY NO. UNITS	UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
REACH D							
Excavation	14,500	CY			20.–		290,000
Gravel Bedding	1450	CY			10.–		14,500
Underlayer Stone	4,300	CY			25.–		107,500
Armor Stone	8,500	CY			30.–		255,000
Sandfill (VF)	2,600	CY			8.–		20,800
Sandfill (BF)	750	CY			8.–		6,000
Beach Access	2	EA			7,000.–		14,000
							(707,800)
REACH E							
Sand	6700	CY			8.–		53,600
Beach Grass	13,200	EA			1.–		13,200
Snow Fence	1700	LF			3.–		5,100
Beach Access	7	EA			7000.–		49,000
							(120,900)
REACH F							
Excavation	600	CY			20.–		12,000
Gravel Bedding	2900	CY			10.–		29,000
Topsoil, seeded	1100	SY			1.50		1,650
PreCast Conc. Wall	960	LF			90.–		86,400
							(129,050)

CONSTRUCTION COST ESTIMATE	DATE PREPARED	SHEET 3 OF 3

PROJECT: POINT OF PINES EL. 16.5' NGVD

LOCATION

ARCHITECT ENGINEER

BASIS FOR ESTIMATE
- [ ] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.

ESTIMATOR: O'LEARY

CHECKED BY

SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
REACH G							
Excavation	1300	CY			20.–		26,000
Gravel Bedding	800	CY			10.–		8,000
Sand fill (BF)	200	CY			8.–		1,600
Topsoil, seeded	800	SY			1.50		1,200
PreCast Conc Wall	760	LF			85.–		64,600
6' Chain Link Fence	500	LF			14.–		7,000
Sand bags	280	EA			5.–		1,400
							(109,800)
SUMMARY							
REACH A							365,600
B							675,200
C							590,700
D							707,800
E							120,900
F							129,050
G							109,800
				sub-total			2,699,050
Pump. Station	1	Job			L.S.		150,000
Site Prep.	1	Job			L.S.		10,000
Mob/Demob	1	Job			L.S.		25,000
							2,884,050
				Contingencies			715,950
						$	3,600,000

ENG FORM 150
1 AUG 59

PREVIOUS EDITION MAY BE USED

* U.S. GOVERNMENT PRINTING OFFICE : 1959 O—516146

CONSTRUCTION COST ESTIMATE	DATE PREPARED 19 Sept. 1984	SHEET 1 OF 1

PROJECT: POINT OF PINES EL. 18.3' NGVD

LOCATION: REVERE MA

ARCHITECT ENGINEER

BASIS FOR ESTIMATE

- [ ] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.	ESTIMATOR	CHECKED BY
	O'LEARY	

SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
Site Prep	1	Job			LS		10,000
Mob/Demob	1	Job			LS		25,000
Excavation	42,100	CY			20.–	–	842,000
Gravel Bedding	9,600	CY			10.–	–	96,000
Underlayer Stone	17,900	CY			25.–	–	447,500
Armor Stone	32,800	CY			30.–	–	984,000
Sandfill (VF)	9,900	CY			8.–	–	79,200
Sandfill (BF)	24,000	CY			8.–	–	192,000
Dune Sand	6700	CY			8.–	–	53,600
Beach Grass	13,200	EA			1.–	–	13,200
Snow Fence	1700	LF			3.–	–	5,100
Beach Access	14	EA			7,000.–	–	98,000
Topsoil, seeded	1900	SY			1.50	–	2,850
PreCast Conc Wall	760	LF			85.–	–	64,600
PreCast Conc Wall	960	LF			90.–	–	86,400
6' Chain Link Fence	500	LF			14.–	–	7,000
Pump. Station	1	Job			L.S.		150,000
Sand bags	280	EA			5.–	–	1,400
							3,157,850
			Contingencies				842,150
						#	4,000,000

ENG FORM 150
1 AUG 59

PREVIOUS EDITION MAY BE USED

* U.S. GOVERNMENT PRINTING OFFICE 1959 O—516148

CONSTRUCTION COST ESTIMATE	DATE PREPARED 18 Sept 1984	SHEET 1 OF 3

PROJECT: POINT OF PINES EL. 18.3' NGVD

LOCATION: REVERE MA.

ARCHITECT ENGINEER: TORNIFOGLIO / O'LEARY

DRAWING NO.: N/A

ESTIMATOR: O'LEARY

CHECKED BY:

BASIS FOR ESTIMATE:
- [ ] CODE A (No design completed)
- [x] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
ESTIMATE by REACH							
REACH A							
Excavation	5700	CY			20.–		114,000
Gravel Bedding	1000	CY			10.–		10,000
Under layer Stone	3000	CY			25.–		75,000
Armor Stone	5700	CY			30.–		171,000
Sandfill (V.F.)	1900	CY			8.–		15,200
Sandfill (B.F.)	6500	CY			8.–		52,000
Beach Access	2	EA			7,000.–		14,000
							(451,200)
REACH B							
Excavation	9500	CY			20.–		190,000
Gravel Bedding	1900	CY			10.–		19,000
Under layer Stone	5900	CY			25.–		147,500
Armor Stone	9200	CY			30.–		276,000
Sandfill (V.F.)	2800	CY			8.–		22,400
Sandfill (BF)	9000	CY			8.–		72,000
Beach Access	1	EA			7,000.–		7,000
							(733,900)
REACH C							
Excavation	9000	CY			20.–		180,000
Gravel Bedding	1400	CY			10.–		14,000
Underlayer Stone	4300	CY			25.–		107,500
Armor Stone	8500	CY			30.–		255,000
Sandfill (V.F)	2300	CY			8.–		18,400
Sandfill (B.F)	7500	CY			8.–		60,000
Beach Access	2	EA			7,000.–		14,000
							(648,900)

ENG FORM 150
1 AUG 59

PREVIOUS EDITION MAY BE USED

CONSTRUCTION COST ESTIMATE	DATE PREPARED 18 Sept. 1984	SHEET 2 OF 3

PROJECT: Point of Pines EL. 18.3' NGVD

LOCATION:

ARCHITECT ENGINEER:

BASIS FOR ESTIMATE:
- [ ] CODE A (No design completed)
- [x] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.: | ESTIMATOR: O'Leary | CHECKED BY:

SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
REACH D							
Excavation	16000	CY			20.–		320,000
Gravel Bedding	1600	CY			10.–		16,000
Underlayer Stone	4700	CY			25.–		117,500
Armor Stone	9400	CY			30.–		282,000
Sandfill (VF)	2900	CY			8.–		23,200
Sandfill (BF)	800	CY			8.–		6,400
Beach Access	2	EA			7,000.–		14,000
							(779,100)
REACH E							
Sand	6700	CY			8.–		53,600
Beach Grass	13200	EA			1.–		13,200
Snow Fence	1700	LF			3.–		5,100
Beach Access	7	EA			7,000.–		49,000
							(120,900)
REACH F							
Excavation	600	CY			20.–		12,000
Gravel Bedding	2900	CY			10.–		29,000
Topsoil & Seed	1100	SY			1.50		1,650
PreCast Conc. Wall	960	LF			90.–		86,400
							(129,050)

CONSTRUCTION COST ESTIMATE

DATE PREPARED: 18 Sept 1984

SHEET 3 OF 3

PROJECT: POINT OF PINES EL. 18.3'NGVD

LOCATION:

ARCHITECT ENGINEER:

BASIS FOR ESTIMATE:

- [ ] CODE A (No design completed)
- [x] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.:

ESTIMATOR: O'LEARY

CHECKED BY:

SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
REACH G							
Excavation	1300	CY			20.–		26,000
Gravel Bedding	800	CY			10.–		8,000
Sandfill (BF)	200	CY			8.–		1,600
Topsoil & Seed	800	SY			1.50		1,200
Sandbags	280	EA			5.–		1,400
Pre Cast Conc. Wall	760	LF			85.–		64,600
6' Chain Link Fence	500	LF			14.–		7,000
(2-10'x6' gates)							(109,800)
SUMMARY:							
REACH A							451,200
B							733,900
C							648,900
D							779,100
E							120,900
F							129,050
G							109,800
				sub-total			2,972,850
Pump Sta (Grav.)	1	Job			L.S.		150,000
Site Prep.	1	Job			L.S.		10,000
Mob/Demob	1	Job			L.S.		25,000
							3,157,850
				contingencies			842,150
							4,000,000

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1 AUG 59

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APPENDIX D

REAL ESTATE

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS

PRELIMINARY ESTIMATE OF REAL ESTATE COSTS
REVERE COASTAL FLOOD PROTECTION STUDY
DPR SECTION 205
POINT OF PINES
REVERE, MASSACHUSETTS

JUNE 1984

PREPARED BY: EDWARD J. FALLON
Review Appraiser

APPROVED BY: WILLIAM D. BROWN, JR.
Chief, Appraisal Branch

REAL ESTATE STUDIES

TABLE OF CONTENTS

PURPOSE

The purpose of this report is to estimate the preliminary real estate costs associated with flood protection at Point of Pines, Revere, Massachusetts, as of June 1984.

INSPECTION OF THE REAL ESTATE

The lands easterly, northerly and along Rice Avenue were viewed in the field during the months of April and May 1984.

DESCRIPTION OF CITY AND PROJECT AREA

The City of Revere is located on the Massachusetts coast about two miles northeast of the City of Boston. About one-fifth of the area is a salt marsh adjacent to the Pines River Estuary, and about one-third of the city, including the marsh area, is below elevation 10 feet, mean sea level. The remainder of the city is gently rolling with a few steep hills, the highest elevation being at the reservior on Fenno's Hill at about 192 feet above mean sea level. Most of the land above 10 feet mean sea level is fully developed. Any future development would be at the expense of existing uses. The population of the city is about 43,000, and on peak summer days more than 20,000 people visit the 3½ miles of Revere Beach for recreational purposes.

PROJECT AREA

POINT OF PINES. This low lying ocean front area in the northeasterly section of Revere consists of permanent year round residences. The area is subjected to flooding from wave overtopping and interior flooding during severe storms. Existing protection consists of a small penninsula of sand dunes and a short section of precast concrete seawall along the easterly shore. There is also a concrete seawall along the northerly side of Rice Avenue.

SCOPE

This report deals with the 100 year and 500 year plans that necessitate acquisition of permanent and temporary easement interests for purposes of construction and maintenance of stone revetments, sand dunes and pre-cast concrete walls along the perimeter of the Point of Pines study area.

The area commences at Carey Circle and extends the length of the coastline, easterly of Rice Avenue, ending at the abutment of General Edwards Bridge.

PROJECT DESCRIPTION

Reach "A" would commence about 200 feet westerly of Carey Circle and would traverse in an easterly direction a distance of about 500 feet ending at Reach "B". A stone revetment at elevation 13.2 feet would be constructed throughout this reach.

Reach "B" commences at Reach "A"'s termination and would continue to traverse in an easterly direction for a distance of about 1300 feet including Reaches "C" and "D" as well. A stone revetment at elevation 16.0 feet would be constructed throughout these Reaches. Upon joining Reach "E" there is an area of transition from stone revetment to a sand fence, which continues in an easterly direction to Reach "F" a distance of about 1730 feet.

Reach "F" commences at the concrete wall at the easterly end of Rice Avenue and traverses about 200 feet at which point it turns and traverses in a northerly direction a distance of about 1035 feet.

Reach "G" commences at the end of Reach "F", adjacent to the pumping station, and traverses in a northerly direction along the property lines of the Point of Pines Yacht Club, along Rice Avenue; between abutter on north and Club House, and then along the shoreline terminating in the abutment of the General Edwards Bridge. Throughout reaches "F" and "G" a pre-cast concrete wall at elevation 13.3 feet NGVD will be used.

RIGHTS TO BE ACQUIRED

Local interests will be required to provide all lands, easements, and rights-of-way necessary for project purposes.

At the present time there are three sections of seawall located on property owned by the Point of Pines Association, that were constructed under a release from damages document(s) but were never recorded for easement usage.

EASEMENTS

Permanent easements will be necessary for maintenance and inspection of the dikes, stone revetments and pre-cast concrete walls. Preliminary investigations indicate that after the imposition of the permanent easement interest, the highest and best use of the remainders of the properties will not be materially affected. The cost to acquire the permanent easement areas would be equivalent to the underlying fee value since those uses would be for project purposes. However, the lands would remain in their private ownerships to maintain conformity of their existing lot areas.

The estimated costs for the easement rights are predicated on the assumption that construction methods will be of the excavation and placement methods that would not adversely affect surface or near surface improvements. If it is determined and found that selected methods of construction would cause damage to surface or near surface improvements then the estimated costs for easement rights would not remain valid and a new in depth real estate study of the proposed taking would be required.

The following costs are predicated on estimated market values as indicated.

.189±	acres private ownership @ $8.00 per sq. ft.	=	$66,000
3.322±	acres private ownership @ $500 per acre	=	1,700
.207±	acres public ownership @ -0-	=	-0-
3.718±	acres Total estimated permanent easement cost		$67,700

TEMPORARY CONSTRUCTION EASEMENTS

Temporary easements 40 feet wide are required during construction periods. In that Rice Avenue abutts most of the project area this roadway will be utilized for purposes of temporary easements during construction.

4.20± acres public ownership @ $-0-	=	$-0-
.758± acres private ownership @ $8.00 per sq. ft.	=	$264,000
4.958± acres Total		$264,000
Fair return on invested capital @15% per year (one year term)		$ 39,600

IMPROVEMENTS

Improvements within the area of protection consist of a single family residence (presently under construction) and a two story wood frame structure which houses the Point of Pines Yacht Club.

TAX LOSS

There is no anticipated tax loss do to permanent easement acquisition in lieu of fee acquisition.

ACQUISITION COSTS

Acquisition costs will include costs for mapping, surveying, legal descriptions, title evidence, appraisals, negotiations, closing and administrative costs for possible condemnations. The acquisition costs are based upon this office's experience in similar civil works projects in this general area and are estimated at $3,000 per ownership. About 8 ownerships will be affected.

RELOCATION ASSISTANCE COSTS

Public Law 91-646, Uniform Relocations Assistance Act of 1970, provided for uniform and equitable treatment of persons displaced from their homes, businesses or farms by a Federally Assisted Program. It also establishes uniform and equitable land acquisition policies for these projects. Included among the items under PL 91-646 are the following:

a. Moving Expenses
b. Replacement Housing (Homeowners)
c. Replacement Housing (Tenants)
d. Relocation Advisory Services
e. Recording Fees
f. Transfer Taxes
g. Mortgage Prepayment Costs
h. Real Estate Tax Refunds (Pro-rata)

Within a reasonable time prior to displacement, the taking authority must certify that there will be available, in areas generally not less desirable and at rents and prices within the financial means of the families and individuals displaced, decent, safe, and sanitary dwellings, equal in number to the number of, and available to, such displaced persons who require such dwellings and reasonably accessible to their places of employment.

There are 8 parcels affected by the permanent easement interest(s). Therefore, the following estimates are included for planning purposes and are limited to expenses incidental to the transfer of real estate interests.

Permanent Easements		
7 Private Ownerships @ $200	=	$1,400
1 Public Ownership @ $200	=	200
8 Total Private & Public Ownerships		$1,600

SEVERANCE DAMAGES

Severance damages can occur when partial takings are acquired which restrict the remaining portion from full economic development. The severance damages are measured and estimated on the basis of "before" and "after" appraisal methods and will reflect actual value loss incurred to the remainder as a result of partial acquisition. Detailed appraisals will reflect any possible losses. Preliminary investigations indicate that there will be no severance damages as all properties will be acquired by way of permanent easement.

PROTECTION AND ENHANCEMENT OF CULTURAL ENVIRONMENT

In accordance with instructions set forth in teletype DA (DAEN) R 191306A, dated October 1971, Subject: "EO11593, 13 May 1971, Protection and Enhancement of Cultural Environment"; a study has been made in the subject areas. The study revealed that no local, State, Federally owned nor Federally-controlled property of historical significance would fall within the provisions of EO11593.

CONTINGENCIES

A contingency allowance of 25 percent is considered to be reasonably adequate to provide for possible appreciation of property values from the time of this estimate to acquisition date, for possible minor property line adjustments or for additional hidden ownerships which may be developed by refinement to taking lines, for adverse condemnation awards and to allow for practical and realistic negotiations.

GOVERNMENT-OWNED FACILITIES

Section III of the act of Congress approved 8 July 1958, (PL 85-500) authorized the protection, realteration, reconstruction, relocation or replacement of municipally-owned facilities. An inspection of the project area indicated that no Government-owned facilities would be affected outside of municipally-owned land.

WATER RIGHTS

The lands that would be acquired by permanent easement will not affect any riparian interests which the owners may have in their properties and they will continue to enjoy access to the water and any other uses which will not interfere with the terms of the easements.

SOIL

The soil of the Point of Pines is mainly white beach sand with a peat base.

MINERALS

There are no known mineral deposits having a commercial value within the project area.

TIMBER

There is no marketable timber within the study area.

AGRICULTURE

There are no commercial agricultural areas within the study area.

CEMETERIES

There are no know cemeteries within the study area.

UTILITIES

Electric power, telephone facilities, sewage and water are available in the study area.

ZONING

Zoning within the study area is general residence.

The requirements for each type of zoning is as follows:

General Residence Zone
Single Family

Lot size: 8,000	Frontage:	80 feet; the structure may cover only 25% of the lot.
Lot size: 10,000	Frontage:	100 feet; the structure may cover only 30% of the lot.

HIGHEST AND BEST USE

The highest and best use of the lands located within the study area, are those of their present use.

EVALUATION AND CONCLUSION

The areas of study for this project are based upon preliminary Engineering Division and Assessors plans supplied by the City of Revere.

The alignments for stone revetments, sanddunes and pre-cast concrete wall areas as well as temporary construction easements are subject to refinement prior to the proposed construction of the project.

The values of lands and improvements within the project area have been estimated by use of the market data or comparable sales approach. Local officials, real estate brokers, appraisers and other knowledgeable persons were contacted to secure data and value estimates.

The estimated values of lands and improvements, as presented are based on a study and analysis of numerous sales and other data gathered during this investigation. The sales used are all located within and in proximity to the study area.

There is no easy or simple way in which real estate sales can be mathematically reduced to a simple value indicator. Each transaction involves not only individual needs, wishes and wants of a particular buyer and particular seller at the time of sale but the properties themselves vary widely as to size, shape, frontage, exposure, location, access, soils conditions, and topography. The appraiser has used as the best common denominator the price per square foot or price per acre with a full understanding that it may be the best available index but it by no means can reflect all the problems.

SUMMARY OF REAL ESTATE COSTS

There follows an estimate of the Real Estate Costs for the proposed local flood protection study in Revere, Massachusetts.

Permanent Easements		
3.718± acres Private and Public Ownership	$67,700	
Temporary Easements		
4.958± acres Private and Public Ownership	39,600	
Total Estimated Permanent and Temporary Easement Cost	$107,300	
Contingency of 25%	26,825	
Total Estimated Easement Costs		$134,125
Relocation Assistance Costs		
7 Private Ownerships @ $200		
1 Public Ownership @ $200		
8 Total Estimated Relocation Assistance Costs		$ 1,600
Acquisition Costs		
7 Private Ownerships @ $3,000		
1 Public Ownership @ $3,000		
8 Total Estimated Acquisition Costs		$ 24,000
Total Estimated Real Estate Costs		$159,725
CALL		$160,000

APPENDIX E

ENVIRONMENTAL NOTIFICATION FORM

APPENDIX A
COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS

ENVIRONMENTAL NOTIFICATION FORM

I. SUMMARY

A. Project Identification

1. Project Name Point of Pines Flood Protection Plan
2. Project Proponent Department of Planning & Comm. Develop.
   Address Revere City Hall, Revere, MA 02151

B. Project Description: (City/Town(s) Revere

1. Location within city/town or street address Point of Pines, from Carey Circle northerly along Rice Ave. to the General Edward's Bridge
2. Est. Commencement Date: 1986 (spring) Est. Completion Date: 1987 (fall)
   Approx. Cost $4.3 million Current Status of Project Design: ______% Complete

C. Narrative Summary of Project

Describe project and give a description of the general project boundaries and the present use of the project area. (If necessary, use back of this page to complete summary).

The recommended Point of Pines Coastal Flood Protection Plan uses three distinctly different types of construction in the seven reaches of Point of Pines. These include:

1) Stone revetment and beach sand replenishment along reaches A to D. Approximately 30,000 cubic yards of sand will be trucked in from a landbased source site for placement over the toe of the revetment structures. The proposed revetment would start with a transition section in Reach A having a top elevation gradually increasing to 16.0 ft. NGVD, with a 1:3 slope down to the existing beach. The grade would gradually reduce from Chamberlain to Alden Ave. to 14.5 ft. NGVD (430 linear ft.) where it meets with Reach E. The sandfill will be distributed down to the -2.6 ft. NGVD contour. Mean low water is at elevation -4.6 ft. NGVD. Alghouth no flood protection benefits are taken for this proposed sand fill, if maintained, it would undoubtedly lower the wave runup.

2) The dune ridges along Reach E will be replenished. The plan will raise the dunes to elevation 14.3 ft. NGVD from Alden Avenue to the mouth of the Saugus River. Here 6,700 CY of sand will be added.

3) The existing sea wall will be reconstructed along Reaches F and G with a top elevation at 13.3 ft. NGVD. Like the other reaches, access to the beach would be provided by walkways over the protection where access currently exists. The entrance to the yacht club would be sand-bagged during flood conditions. (See Plan #2 for details of Reaches A-G)

Copies of this may be obtained from:
Name: Frank Stringi Firm/Agency: Department of Planning & Comm. Develo
Address: Revere City Hall, Revere, MA 02151 Phone No. 284-3600 ext. 111

1979 THIS IS AN IMPORTANT NOTICE. COMMENT PERIOD IS LIMITED.
For Information, call (617) 727-5830

Use This Page to Complete Narrative, if necessary.

Point of Pines is a low lying peninsula at the mouth of the Saugus River extending seaward northeast of Revere Beach and is bounded by the Pines River to the west, Saugus River to the North and Atlantic Ocean to the east. (See Plan #1). Point of Pines is a heavily settled residential area consisting of over 360 dwellings.

This project is one which is categorically included and therefore automatically requires preparation of an Environmental Impact Report: YES______ NO X

D. Scoping (Complete Sections II and III first, before completing this section.)

1. Check those areas which would be important to examine in the event that an EIR is required for this project. This information is important so that significant areas of concern can be identified as early as possible, in order to expedite analysis and review.

	Construction Impacts	Long Term Impacts		Construction Impacts	Long Term Impacts
Open Space & Recreation	X	X	Mineral Resources		
Historical			Energy Use		
Archaeological			Water Supply & Use		
Fisheries & Wildlife			Water Pollution		
Vegetation, Trees			Air Pollution		
Other Biological Systems			Noise	X	
Inland Wetlands			Traffic	X	
Coastal Wetlands or Beaches	X	X	Solid Waste		
Flood Hazard Areas			Aesthetics	X	X
Chemicals, Hazardous Substances,			Wind and Shadow		
High Risk Operations			Growth Impacts		
Geologically Unstable Areas			Community/Housing and the Built		
Agricultural Land			Environment		
Other (Specify)					

2. List the alternatives which you would consider to be feasible in the event an EIR is required.

All other alternative plans are not considered feasible since they would not provide the same degree of flood protection as this plan. These include, no action breakwaters, total beach replenishment, a number of wall alternatives and non structural measures such as floodproofing. (See Exhibit A for a brief overview of some of these alternatives).

E. Has this project been filed with EOEA before? Yes _____ No __x__
If Yes, EOEA No. __________ EOEA Action? __________

F. Does this project fall under the jurisdiction of NEPA? Yes __x__ No _____
If Yes, which Federal Agency? __Corps of Engineers__ NEPA Status? __________

G. List the State or Federal agencies from which permits will be sought:

Agency Name	Type of Permit
U. S. Army Corps of Engineers	Sec. 404 Clean Water Act
DEQE	Water Quality Certificate

H. Will an Order of Conditions be required under the provisions of the Wetlands Protection Act (Chap. 131, Section 40)?
Yes __X__ No _____
DEQE File No., if applicable: __________

I. List the agencies from which the proponent will seek financial assistance for this project:

Agency Name	Funding Amount
U. S. Army Corps of Engineers Small Protects Program Sec. 205 under 1948 Flood Control Act	$4 million

II. PROJECT DESCRIPTION

A. **Include an original 8½x11 inch or larger section of the most recent U.S.G.S. 1:24,000 scale topographic map *with the project area location and boundaries clearly shown. Include multiple maps if necessary for large proj-*ects. Include other maps, diagrams or aerial photos if the project cannot be clearly shown at U.S.G.S. scale. If available, attach a plan sketch of the proposed project.**

B. State total area of project: __5 acres__
Estimate the number of acres (to the nearest 1/10 acre) directly affected that are currently:

1. Developed .... __0__ acres
2. Open Space/Woodlands/Recreation __2__ acres
3. Wetlands .... __0__ acres
4. Floodplain .... __5__ acres
5. Coastal Area .... __5__ acres
6. Productive Resources
   - Agriculture .... __0__ acres
   - Forestry .... __0__ acres
   - Mineral Products .... __0__ acres

C. Provide the following dimensions, if applicable:
Length in miles __5000 ft.__ Number of Housing Units __NA__ Number of Stories __NA__

	Existing	Immediate Increase Due to Project
Number of Parking Spaces	NA	
Vehicle Trips to Project Site (average daily traffic)	NA	
Estimated Vehicle Trips past project site	NA	

D. If the proposed project will require any permit for access to local or state highways, please attach a sketch showing the location of the proposed driveway(s) in relation to the highway and to the general development plan; identifying all local and state highways abutting the development site; and indicating the number of lanes, pavement width, median strips and adjacent driveways on each abutting highway; and indicating the distance to the nearest intersection.

III. ASSESSMENT OF POTENTIAL ADVERSE ENVIRONMENTAL IMPACTS

Instructions: Consider direct and indirect adverse impacts, including those arising from general construction and operations. For every answer explain why significant adverse impact is considered likely or unlikely to result.

Also, state the *source* of information or other basis for the answers supplied. If the source of the information, in part or in full, is not listed in the ENF, the preparing officer will be assumed to be the source of the information. Such environmental information should be acquired at least in part by field inspection.

A. Open Space and Recreation

1. Might the project affect the condition, use or access to any open space and/or recreation area?
   Yes __X__ No ____

   Explanation and Source:

The proposed rock revetment for Reaches A to D will cover approximately 1.0 to 1.5 acres of shorefront along the beach. However, sand will be placed seaward of the rock revetment to replace the loss of beach and provide the protection. About one acre of new beach above MHW would be created along Reaches A to D. Access to the beach area will be maintained in those areas where public access currently exists.

B. Historic Resources

1. Might any site or structure of historic significance be affected by the project? Yes ____ No __X__

   Explanation and Source:

None of the properties which are listed in the National Register of Historic Places or any local or state registers are located within the project boundaries.

Historical Commission - City of Revere

2. Might any archaeological site be affected by the project? Yes ____ No __X__

   Explanation and Source:

Project area is located in a Coastal area where prior development of seawalls and rock revetments have already distrubed the project area.

C. Ecological Effects

1. Might the project significantly affect fisheries or wildlife, especially any rare or endangered species?
   Yes ____ No __X__

   Explanation and Source:

The U. S. Fish and Wildlife Service reports that the upper beach habitat, where construction is to take place is sparsely populated with beach fleas, small crabs, sand dollars, shrimp and lance found in the intertidal zone. There would be no long term impact on fish and wildlife resources within the project area. The U. S. Fish and Wildlife Service further states that no Federally listed endangered species are known to exist in the project impact area.

2. Might the project significantly affect vegetation, especially any rare or endangered species of plant?
Yes ____ No __X__
(Estimate approximate number of mature trees to be removed: ________)

Explanation and Source:

The proposed sand dune restoration for Reach E would involve placement of 6,700 c.y. of sand elevating the dunes to a uniform height of 14.3 NGUD, placement of sand fences and vegetation planting with American Beach Grass. Approximately 0.5 acres of dunes would be planted. The area that would be impacted by the structural plan contains no trees or other significant vegetation.

3. Might the project alter or affect flood hazard areas, inland or coastal wetlands (e.g., estuaries, marshes, sand *dunes and beaches, ponds, streams, rivers, fish runs, or shellfish beds)?* Yes __x__ No ____

Explanation and Source:

The recommended flood protection plan utilizes existing concrete floodwalls to best advantage and adds structural improvements (revetments) as well as rebuilding and renourishment of the dunes area to provide protection up to the 100 year flood level. This plan will not alter or affect any estuary, marsh, pond, stream, river, fish run, or shellfish bed. Rebuilding and renourishment of the dunes and beach area effectively provides the design flood protection with additional benefit of environmental protection.

4. Might the project affect shoreline erosion or accretion at the project site, downstream or in nearby coastal areas? Yes ____ No __X__

Explanation and Source:

About 1.5 acres of beach would be added along the shore from Reaches A to E. This sand replenishment would not interfere with the natural supply or movement. Although it would add new sand into the system, the new sediments would be redistributed by wave and tidal action within the self contained beach unit.

5. Might the project involve other geologically unstable areas? Yes ____ No __X__

Explanation and Source:

No geologically unstable areas exist within the project area.

D. Hazardous Substances

1. Might the project involve the use, transportation, storage, release, or disposal of potentially hazardous substances?
Yes ____ No __x__

Explanation and Source:

No hazardous substances will be used or generated by this project.

E. Resource Conservation and Use

1. Might the project affect or eliminate land suitable for agricultural or forestry production?
   Yes ______ No __x__
   (Describe any present agricultural land use and farm units affected.)

   Explanation and Source:

Project area is a coastal shoreline where no agriculture or forestry production currently exists.

2. Might the project directly affect the potential use or extraction of mineral or energy resources (e.g., oil, coal, sand & gravel, ores)? Yes ______ No __X__

   Explanation and Source:

There are no known mineral or energy resources within the project area.

3. Might the operation of the project result in any increased consumption of energy? Yes ______ No __X__

   Explanation and Source:
   (If applicable, describe plans for conserving energy resources.)

Project will not result in any increased consumption of energy since it will not require any operational function.

F. Water Quality and Quantity

1. Might the project result in significant changes in drainage patterns? Yes ______ No __X__

   Explanation and Source:

The project will not alter any interior drainage patterns as its main function is to dissipate wave energy and reduce tidal surge.

2. **Might the project result in the introduction of pollutants into any of the following:**
   (a) Marine Waters .... Yes ______ No __X__
   (b) Surface Fresh Water Body .... Yes ______ No __x__
   (c) Ground Water .... Yes ______ No __x__

   Explain types and quantities of pollutants.

3. Will the project generate sanitary sewage? Yes ______ No __x__

If Yes, Quantity: __________ gallons per day

Disposal by: (a) Onsite septic systems .... Yes ______ No ______
(b) Public sewerage systems .... Yes ______ No ______
(c) Other means (describe) ______________________________

4. Might the project result in an increase in paved or impervious surface over an aquifer recognized as an important present or future source of water supply? Yes ______ No __X__

Explanation and Source:

Project involves flood protection over a shoreline where no known aquifer or water source exists.

5. Is the project in the watershed of any surface water body used as a drinking water supply?
Yes ______ No __X__

Are there any public or private drinking water wells within a 1/2-mile radius of the proposed project?
Yes ______ No __X__

Explanation and Source:

There are no public or private wells and no watershed used for a drinking water supply in the project area. Local drinking water is derived from the MDC water distribution system.

6. Might the operation of the project result in any increased consumption of water? Yes ______ No __x__

Approximate consumption ________ gallons per day. Likely water source(s) ______________________

Explanation and Source:

7. Does the project involve any dredging? Yes ______ No __X__

If Yes, indicate:

Quantity of material to be dredged ______________________
Quality of material to be dredged ______________________
Proposed method of dredging ______________________
Proposed disposal sites ______________________
Proposed season of year for dredging ______________________

Explanation and Source:

G. Air Quality

1. Might the project affect the air quality in the project area or the immediately adjacent area?
   Yes ____ No __X__

   Describe type and source of any pollution emission from the project site.

Project will not generate any pollution other than dust during construction.

2. Are there any sensitive receptors (e.g., hospitals, schools, residential areas) which would be affected by any pollution emissions caused by the project, including construction dust? Yes __X__ No ____

   Explanation and Source:

The adjacent shorefront residential properties would be subject to dust generation traditionally associated with construction activity.

3. Will access to the project area be primarily by automobile? Yes ____ No __X__
   Describe any special provisions now planned for pedestrian access, carpooling, buses and other mass transit.

The project area is adjacent to a densely settled residential area. Access to the project area will be primarily by foot or bicycle over wooden ramps which will be constructed over the sand dunes to provide access to the beach.

H. Noise

1. Might the project result in the generation of noise? Yes __X__ No ____

   Explanation and Source:
   (Include any source of noise during construction or operation, e.g., engine exhaust, pile driving, traffic.)

Noise will be generated during construction activity due to the increase in truck traffic through the neighborhood.

2. Are there any sensitive receptors (e.g., hospitals, schools, residential areas) which would be affected by any noise caused by the project? Yes __X__ No ____

   Explanation and Source:

The Point of Pines neighborhood would be subject to noise generated by the truck traffic during construction activity.

I. Solid Waste

1. Might the project generate solid waste? Yes ____ No _X_

Explanation and Source:
(Estimate types and approximate amounts of waste materials generated, e.g., industrial, domestic, hospital, sewage sludge, construction debris from demolished structures.)

All excavated sand and gravel will be used within the project area as toe protection to the revetment stone.

J. Aesthetics

1. Might the project cause a change in the visual character of the project area or its environs?
Yes _X_ No ____

Explanation and Source:

Reaches A to D of the project area would change in visual character, as the proposed rock revetment would extend 60 to 80 ft. seaward from the existing structure and extend about 2 ft. higher than the existing structure.

2. Are there any proposed structures which might be considered incompatible with existing adjacent structures in the vicinity in terms of size, physical proportion and scale, or significant differences in land use?
Yes _X_ No ____

Explanation and Source:

The rock revetment constructed from Reaches A to D is a continuation and enlargement of the existing revetment extending 2 ft. higher and some 60 to 80 ft. seaward of the existing structures.

3. Might the project impair visual access to waterfront or other scenic areas? Yes _X_ No ____

Explanation and Source:

In Reaches A to D the plan will raise shoreline structures up to 2 ft. and along Reaches F and G up to 8 inches higher than existing structures affecting water views for residences in this area.

K. Wind and Shadow

1. Might the project cause wind and shadow impacts on adjacent properties? Yes ____ No _X_

Explanation and Source:

The project will not cause any major wind or shadow impacts on adjacent properties.

IV. CONSISTENCY WITH PRESENT PLANNING

A. Describe any known conflicts or inconsistencies with current federal, state and local land use, transportation, open space, recreation and environmental plans and policies. Consult with local or regional planning authorities where appropriate.

There are no known conflicts or inconsistencies with current federal, state or local plans and policies. This project is a direct result of public concern for flood protection and through a number workshop meetings with residents and government officials, this plan has been formulated to provide a high degree of protection (100 year flood event) while being sensitive to the design impact concerns and beach user needs of the residents.

V. FINDINGS AND CERTIFICATION

A. The notice of intent to file this form has been/will be published in the following newspaper(s):

(Name) Revere Journal (Date) November 7, 1984

B. This form has been circulated to all agencies and persons as required by Appendix B.

11/14/84 — Date

Frank Stringi — Signature of Responsible Officer or Project Proponent

Frank Stringi
Name (print or type)

Address Dept. of Planning & Comm. Develop.
Revere City Hall, Revere, MA 02151
Telephone Number 284-3600 ext. 111

Date ____________

Signature of person preparing ENF (if different from above) ____________

Name (print or type) ____________

Address ____________

Telephone Number ____________

EXHIBIT A

II. ALTERNATIVES CONSIDERED

In the early stages of plan formulation, a number of alternatives were investigated but eliminated from consideration due to their prohibitive costs or environmental impacts (a more detailed discussion is presented in the main report). These include, but are not limited to: breakwater(s), total beach replenishment, a number of wall alternatives, and non-structural measures such as floodproofing. A brief overview of some of these alternatives and the associated environmental impacts comprise this section.

No Action - The "no action" or without condition is based on the most probable future condition, assuming no new Federal participation in water resources projects in the Point of Pines area. Under this situation, no implementation of methods to alleviate or reduce the flood problems would be expected. Both the monetary investment and potential adverse impacts associated with structural improvements would be avoided. However, this would subject Point of Pines to continued flooding which threatens both man's environment and a portion of the terrestrial, coastal ecology as it exists today. Man's well being is significantly affected by storms whose destruction is made more evident by denuded beaches, destroyed homes and businesses, and threatened lives. With continued flooding, property values would decline, the beach biome degrade, and the area suffer the associated economic and physical losses.

Non-Structural Alternatives

A general survey conducted by the Corps of Engineers showed nonstructural measures such as floodproofing, building code and zoning regulations and public acquisition of flood hazard lands; to receive relatively low preference from residents, except for two: (1) expanding flood insurance coverage and (2) developing a community-wide warning and evacuation plan. Survey results indicated general preference for measures which would actually provide flood damage reduction, but result in the least disruption to individual personal properties. These non-structural measures would appear to represent the least environmental disturbance; however, they make were eliminated because the type of severe flooding experienced by Point of Pine tradtional non-structural measures inappropriate. If non-structural measures are implemented without shoreline protection, the area will still be subject to deep flooding and possible loss of life.

Structural Alternatives

Shoreline Revetment. The construction of onshore structures is the most direct method of protecting a shoreline from continued flooding or erosion. Although there are many types of revetments and many kinds of material available for their construction, a rock riprap type as proposed, would be the most practical and feasible type for reaches A-D of the Point of Pines shoreline based on existing conditions, cost, ease of construction, availabilty of materials, durability, and maintenance. Concrete walls alone are not feasible at Point of Pines due to their excessive costs. Also, their required massive heights would have severe impacts on study area aesthetics. The rock revetments have been kept to the minimum width feasible, but must be constructed seaward of existing seawalls due to physical constraints.

The major disadvantages of a revetment is its man-made appearance and potential impacts it might have on the beach due to the possible modifications in longshore sediment transport (US Fish and Wildlife Service, 1980). The 1,570 foot long structure proposed for Reaches A to D, would permanently protect the backshore area from flooding and erosion and would be aesthetically compatible with the existing poured and precast concrete walls and revetments characterizing the area. A sand beach would be constructed in conjunction with the revetment plan.

The proposed plan of protection for Reach E would include raising the low points of existing dunes to elevation 14.3 ft NGVD and selective planting of beach grass to stabilize the area. It is estimated that 6,700 cubic yards of sandfill would be required. In order to allow for access to the beach wooden ramps would be constructed over the dunes. These would be located at the ends of existing streets. A rolled, portable "sand" fence would extend along the dune crest between the access ramps in order to minimize foot traffic over the top of the dunes and prevent possible erosion.

Dune planting with appropriate grasses reduces windborne losses landward and aids in dune preservation. It is recommended that the American Beach Grass (Ammophilia brevigulata) be mixed with 10% (Panicum Amarum). It is also recommended that a variety of beach grass adaptive to low sand movement be used, which is better suited for stabilization.

Seawalls. Protection of shore development can be accomplished by constructing wave-resistant walls of various types. Seawalls may have vertical, curved or stepped faces. While seawalls may protect development, they can also create a problem. The downward forces created by waves striking the wall can rapidly remove sand from in front of the wall. A stone apron is often necessary to prevent this excessive scouring and undermining. A seawall constructed on piles with sheet pile cutoff walls would be effective in minimizing tidal flood damage to development behind the wall. However, without widening and raising the beach berm in front of the wall, wave action would accelerate the loss of beach material. Therefore, any plan which considers seawall construction must include measures to protect the beach. Beach berm construction and nourishment, along with a seawall, can be an effective tidal flood protection measure.

A pre-cast concrete seawall, with top elevation 13.3 ft NGVD, is proposed for Reaches F and G. It would run along the alignment of the existing protective structures along the Saugus River. In this manner, preservation of the existing condition is accomplished as much as practical while still providing the flood protection needed.

The Proposed Plan - Generally, the selected plan of protection utilizes existing protection to best advantage and adds structural improvements to increase their effectiveness for flood control. Rebuilding and renourishment of the dunes area at Point of Pines effectively provides the design flood protection with additional benefit of environmental preservation, compatible with community desires.

The proposed improvements are economically feasible, cause the least disruption to private properties and minimum loss of recreational beach area, and is the plan of protection which reasonably maximizes net economic benefits. The proposed plans as described in Section I, will have no significant impacts upon fish and wildlife resources (See F&WS Planning Aid letter). However there would be minor losses, from disturbance during construction, of the shore and beach habitat covered by the measures. Public access to the beaches would be maintained wherever it is currently available, and measures to confine people to walkways will be provided to prevent dune erosion and protect vegetation.

Form 3

Commonwealth of Massachusetts

DEQE File No. ________ (To be provided by DEQE)

City/Town ________

Applicant ________

Notice of Intent Under the Massachusetts Wetlands Protection Act, G.L. c. 131, §40 and Application for a Department of the Army Permit

Part I: General Information

1. Location: Street Address Point of Pines, Revere
   Lot Number ________

2. Project: Type Flood Control Description The extent of shoreline protection being proposed begins at Carey Circle and runs northeasterly and westerly along Rice Ave. to the General Edwards Bridge comprising some 5000 ft. of shoreline. The plan being proposed by the Corps of Engineers involves a combination of four measures of shoreline protection for a 100 year flood design at various locations between Carey Circle and the General Edwards Bridge including: 1) rock revetment; 2) seawall improvements; 3) beach replenishment; and 4) dune restoration.

3. Registry: County ________ Current Book ________ & Page ________
   Certificate (If Registered Land) ________

4. Applicant Dept. of Planning and Community Development Tel. 284-3600 ext. 11
   Address Revere City Hall, Revere, MA 02151

5. Property Owner Point of Pines Beach Association and various private property owners. Tel. ________
   Address ________

6. Representative ________ Tel. ________
   Address ________

7. Have the Conservation Commission and the DEQE Regional Office each been sent, by certified mail or hand delivery, 2 copies of completed Notice of Intent, with supporting plans and documents?
   Yes ☑ No ☐

8. Have all obtainable permits, variances and approvals required by local by-law been obtained?
Yes ☐ No ☐ NA

Obtained:	Applied For:	Not Applied For:

9. Is any portion of the site subject to a Wetlands Restriction Order pursuant to G.L. c. 131, §40A or G.L. c. 130, §105? Yes ☐ No ☒

10. List all plans and supporting documents submitted with this Notice of Intent.

Identifying Number/Letter	Title, Date
Exhibit A	Point of Pines General Plan
Exhibit B	Point of Pines Typical Sections
Exhibit C	Environmental Assessment

11. Check those resource areas within which work is proposed:

(a) ☐ Buffer Zone

(b) Inland:

- ☐ Bank*
- ☐ Bordering Vegetated Wetland*
- ☐ Land Under Water Body & Waterway*

Land Subject to Flooding,

- ☐ Bordering
- ☐ Isolated

(c) Coastal:

- ☐ Land Under the Ocean*
- ☒ Coastal Beach*
- ☐ Barrier Beach
- ☐ Rocky Intertidal Shore*
- ☐ Land Under Salt Pond*
- ☐ Fish Run*
- ☐ Designated Port Area*
- ☐ Coastal Dune
- ☐ Coastal Bank
- ☐ Salt Marsh*
- ☐ Land Containing Shellfish*

*Likely to involve U.S. Army Corps of Engineers concurrent jurisdiction. See General Instructions for Completing Notice of Intent.

Part II: Site Description

Indicate which of the following information has been provided (on a plan, in narrative description or calculations) to clearly, completely and accurately describe existing site conditions.

Identifying Number/Letter (of plan, narrative or calculations)	
	Natural Features:
B	Soils
A	Vegetation
A	Topography
A	Open water bodies (including ponds and lakes)
A	Flowing water bodies (including streams and rivers)
NA	Public and private surface water and ground water supplies on or within 100 feet of site
NA	Maximum annual ground water elevations with dates and location of test
A	Boundaries of resource areas checked under Part I, item 11 above
	Other
	Man-made Features:
B	Structures (such as buildings, piers, towers and headwalls)
A &B	Drainage and flood control facilities at the site and immediately off the site, including culverts and open channels (with inverts), dams and dikes
NA	Subsurface sewage disposal systems
NA	Underground utilities
NA	Roadways and parking areas
A	Property boundaries, easements and rights-of-way
	Other

Part III: Work Description

Indicate which of the following information has been provided (on a plan, in narrative description or calculations) to clearly, completely and accurately describe work proposed within each of the resource areas checked in Part I, item 11 above.

Identifying Number/Letter (of plan, narrative or calculations)	
	Planview and Cross Section of:
A&B	Structures (such as buildings, piers, towers and headwalls)
A&B	Drainage and flood control facilities, including culverts and open channels (with inverts), dams and dikes
NA	Subsurface sewage disposal systems & underground utilities
C	Filling, dredging and excavating, indicating volume and composition of material
NA	Compensatory storage areas, where required in accordance with Part III, Section 10:57 (4) of the regulations
	Other
	Point Source Discharge
	Description of characteristics of discharge from point source (both closed and open channel), when point of discharge falls within resource area checked under Part I, item 11 above, as supported by standard engineering calculations, data and plans, including but not limited to the fo[illegible]ing:

1. Delineation of the drainage area contributing to the point of discharge;
2. Pre- and post-development peak run-off from the drainage area, at the point of discharge, for at least the 10-year and 100-year frequency storm;
3. Pre- and post-development rate of infiltration contributing to the resource area checked under Part I, item 11 above;
4. Estimated water quality characteristics of pre- and post-development run-off at the point of discharge.

Part IV: Mitigating Measures

1. Clearly, completely and accurately describe, with reference to supporting plans and calculations where necessary:
   (a) All measures and designs proposed to meet the performance standards set forth under each resource area specified in Part II or Part III of the regulations; or
   (b) why the presumptions set forth under each resource area specified in Part II or Part III of the regulations do not apply.

☒ Coastal ☐ Inland — Resource Area Type: Coastal Beach	Identifying number or letter of support documents
Project is for flood protection up to the 100 year flood design. Beach replenishment and dune restoration are flood control measures as well as for recreation and environmental preservation. Proposed seawall improvements and rock revetment are structural flood control measures.	A,B&C

☐ Coastal ☐ Inland — Resource Area Type:	Identifying number or letter of support documents

☐ Coastal ☐ Inland	Resource Area Type:	Identifying number or letter of support documents

2. Clearly, completely and accurately describe, with reference to supporting plans and calculations where necessary:

   (a) all measures and designs to regulate work within the Buffer Zone so as to insure that said work does not alter an area specified in Part I, Section 10.02(1) (a) of these regulations; or

   (b) if work in the Buffer Zone will alter such an area, all measures and designs proposed to meet the performance standards established for the adjacent resource area specified in Part II or Part III of these regulations.

☐ Coastal ☐ Inland	Resource Area Type Bordered By 100-Foot Discretionary Zone:	Identifying number or letter of support documents
	NA	

Part V: Additional Information for a Department of the Army Permit

1. COE Application No.________________ 2.______________________
(to be provided by COE) (Name of waterway)

3. Names and addresses of property owners adjoining your property:

4. Document other project alternatives (i.e., other locations and/or construction methods, particularly those that would eliminate the discharge of dredged or fill material into waters or wetlands).

5. 8½" x 11" drawings in planview and cross-section, showing the resource area and the proposed activity within the resource area. Drawings must be to scale and should be clear enough for photocopying.

Certification is required from the Division of Water Pollution Control before the Federal permit can be issued. Certification may be obtained by contacting the Division of Water Pollution Control, 1 Winter Street, Boston, Massachusetts 02108.

Where the activity will take place within the area under the Massachusetts approved Coastal Zone Management Program, the applicant certifies that his proposed activity complies with and will be conducted in a manner that is consistent with the approved program.

Information provided will be used in evaluating the application for a permit and is made a matter of public record through issuance of a public notice. Disclosure of this information is voluntary; however if necessary information is not provided, the application cannot be processed nor can a permit be issued.

I hereby certify under the pains and penalties of perjury that the foregoing Notice of Intent and accompanying plans, documents and supporting data are true and complete, to the best of my knowledge.

Frank Stringi ______________________ Nov. 14, 1984
Signature of Applicant Date

______________________ ______________
Signature of Applicant's Representative Date

NED FORM 100 (TEST)
1 MAY 82

"Exception to ENG Form 4345 approved by HQUSACE, 6 May 1982".

"This document contains a joint Department of the Army and State of Massachusetts application for a permit to obtain permission to perform activities in United States waters. The Office of Management and Budget (OMB) has approved those questions required by the US Army Corps of Engineers. OMB Number 0702-0036 and expiration date of 30 September 1983 applies". This statement will be set in 6 point type.

APPENDIX F

ECONOMICS

POINT OF PINES
ECONOMIC APPENDIX

METHODOLOGY

The economic justification of the proposed improvements was determined by comparing the average annual benefits accruing to the project to the average annual costs of the project over its economic life. For the Federal Government to participate in the project, annual benefits should equal or exceed annual costs.

Benefits and costs are made comparable by conversion to an equivalent time basis using an interest rate of 8-1/8%. This rate, as specified in the Federal Register, is to be used by federal agencies in the formulation and evaluation of water and related land resources plans for the period 1 October 1983 through and including 30 September 1984. All costs and benefits in this appendix are stated at the January 1984 price level. The project economic life is considered to be 100 years.

The analysis of costs and benefits follows standard U.S. Army Corps of Engineers procedures. The reference document used in the benefit estimation process is Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, 10 March 1983; Section IV - NED Benefit Evaluation Procedures: Urban Flood Damage.

DAMAGE SURVEY

Initial damage surveys were undertaken in 1978. More detailed damage surveys were undertaken in the fall of 1980. Property owners, tenants and local officials were contacted and interviewed to obtain current flood damage losses. The stage at which flood damage begins was determined for each property. Estimates of potential damages were then made from the starting point, in 1 foot increments of stage, to a level 3 feet above the stage of the February 1978 flood. Dollar value estimates were made for physical damages to site, structure, contents and utilities. Estimates of income losses to business resulting from a disruption of normal activities were also determined.

Stage-damage estimates for residential properties were prepared using typical stage-damage relationships for 10 categories of residential structures. The 10 categories are listed in Exhibit 1.

EXHIBIT 1
CATEGORIES OF RESIDENTIAL STRUCTURES

1. One Story, No Basement
2. One Story, with Basement
3. Two Story, No Basement
4. Two Story, with Basement
5. Split Level

6. Duplex
7. Two Family, No Basement
8. Two Family, with Basement
9. Three Family, No Basement
10. Three Family, with Basement

The types of damages included in the estimates are displayed in Exhibit 2. References used in the preparation of the estimates are presented in Exhibit 3. Damage estimates were referenced to the first floor of the residence and made in 1 foot increments. An example of a typical stage damage sheet is presented in Exhibit 4.

EXHIBIT 2
DAMAGES INCLUDED IN SURVEY

1. Basement - structural cleanup and other: basement or cellar floors, Sub-basement foundation, exterior and interior walls, cleaning and carting.

- Utilities: Heat, electricity, plumbing, gas, and air conditioning including losses for possible damage to, removal and replacement of heating plant and water heater, electrical board, water and sewage pipes, sink and lavatory, gas meter and air conditioning unit.

- Contents: Furnishing, tools, sporting equipment, garden furniture and storage chests.

2. Outside - grounds, fencing, driveway, storage sheds, pool and landscaping.

3. 1st floor and above - first floor interior and exterior walls, windows, doors, and cabinets, fixtures, plumbing and electrical equipment, outlets, and ceilings.

- Contents: Furnishings, refrigerator, freezer, rugs, drapes, clothing, food, pots and pans, dishes, silverware, small appliances, and large appliances (providing they are not in the basement).

- Garage: Car, structure and contents.

4. Non-Physical Losses

One hundred fifty dollars per day per family was estimated for the expense of being out of homes. This includes the cost of shelter and food. In the case of single person $90 per day is reasonable for lodging, food and incidentals, at this particular time and in this area.

$60.00 for a room
$30.00 for food and incidentals, possibly clothing

This $150.00 figure for families and the $90.00 per single person were average figures.

EXHIBIT 3

REFERENCES

1. Means, Robert S. Building Construction Cost Data. Kingston, Mass., R.S. Means Co., Inc., Annually.

2. Richardson General Construction Estimating Masonry Metals, Solana Beach, Cal., Richardson Eng. Serv. Inc., Annual.

3. McMahon, Leonard A., Dodge Guide to Public Works Heavy Construction and Building Construction. N.Y.C. McGraw-Hill Annual.

4. McMaster-Carr Catalogue. Chicago McMaster-Carr Supply Co., Annual.

5. Hilbok, Albert J., Building Costs, Berger Design Cost. File MBM Inc., Annual.

6. MicKadeit, Robert E., Building Construction Materials & Types of Construction. N.Y. John Wiley & Sons 1975.

7. Montgomery Ward Catalogue. Albany, N.Y., Montgomery Ward Co., Inc., Annually.

8. New England Real Estate Journal New England, R.E., Journal Accord, Mass., Weekly.

9. Mass. R.E. Banking and Commercial Weekly. Banker & Tradesman. Warren Publishing Corp., Boston, Mass., Weekly.

10. Sears Roebuck & Co. Annually.

11. Brewsters. Prov., R.I., Quarterly.

Through field visits, a structure description form was completed for each residence. Both the first floor elevation and the elevation at which flood damage starts were determined using topographic mapping and field surveys. A sample of a residential information form is provided as Exhibit 5. A photograph of each residence was also obtained.

NEW ENGLAND DIVISION CORPS OF ENGINEERS
FLOOD LOSSES - RESIDENTIAL

EXHIBIT 4

River or Stream/Tidal Pines River/Atlantic Ocean
State ____ Side of River (R. or L. looking downstream)
Town Revere Village Point of Pines
Company or Owner
Address
Source of Information
1. DESCRIPTION Typical two story, one family w/basement

No. of stories: Two ; ____ Type One family w/bsmt
Size ____ Mat'l ____
Use ____ Stud Hgt ____
Record Flood El ____ Cellar ____ 1st Floor ____
Height of 1st Floor above ground: Front ____ Rear ____

ASSESSMENT: LAND ____ BUILDING ____ LAND AREA ____ RECENT SALE ____

Flood Date ____ Recurring Loss in $1000 Units

				-8		-6		-4		-2		1st Fl	+1	+2	+3		REMARKS	
Bsmt. Struct. Cleanup & Other				0.2	1.0	2.0	2.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Util. - Heat, Elec, Plum, Gas, AC					2.0	2.0	2.0	3.2	3.2	3.2	3.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
Contents - Furn, Tools, Sport Gds					0.2	0.3	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Sub Total																		
Outside - Grounds, Fence, Drive				0.1	0.1	0.1	0.3	0.3	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1st Floor Struct. & above												8.2	8.5	14.5	16.0	16.5	16.5	16.5
Contents													7.3	10.4	12.1	13.9	13.9	13.9
Car - Gar.													1.4	1.7	5.3	5.6	5.6	5.6
TOTAL																		
Added Cost of Food, room, Time-Necessities																		
Other Cost																		
TOTAL NON-PHYSICAL					0	.2	.2	.2	.3	.3	.3	1.1	1.1	2.1	2.1	3.2	3.2	4.2
TOTAL PHYSICAL & NON-PHYSICAL			0	.3	3.3	4.6	5.3	9.5	9.8	9.8	9.8	19.8	28.8	39.2	46.0	49.7	49.7	50.7

OTHER SIMILAR STRUCTURES

ADDRESS	DIFF.SIZE	DIFF ELEV.	NOTES	ADDRESS	DIFF SIZE	DIFF ELEV.	NOTES

DATE Jan 1983 Price Level SURVEYED BY:

Sh. No. DF 16-20
Deck 2

EXHIBIT 5
RESIDENTIAL FLOOD PLAIN INFORMATION FORM

Visual Inspection Information

Occupant (if known):

Address:

City or Town:

Type of Construction: Frame: ( ) Brick: ( ) Concrete: ( ) Other: ( )
Type of Structure: Ranch: ( ) Split: ( ) Cape: ( ) Colonial: ( )
2-Story: ( ) 3-Story: ( ) Cottage: ( ) Camp: ( )
Duplex: ( ) Contemporary: ( ) Converted Mobile
Home: ( ) Other: ( )

Families in Dwellings: 1: ( ) 2: ( ) 3: ( ) More: ( )
Number of stories: 1: ( ) 1-1/2: ( ) 2: ( ) 2-2 1/2: ( ) 3: ( )
More: ( )

Basement: Yes: ( ) No: ( )
Type of Basement: Brick: ( ) Concrete: ( ) Stone: ( ) Concrete: ( )
Block: ( )

Garage: In structure: ( ) Attached: ( ) Separate: ( ) None: ( )
Spaces: 1: ( ) 2: ( ) 3: ( )
Floor: Ground level: ( ) Below: ( )

Elevation of ground at foundation: NGVD
Height of first floor: ft. (right front)
Height of first floor: ft. (front entrance)
Height of first entry: ft.

Other Comments:

RECURRING FLOOD LOSSES

Recurring losses are those potential damages which are expected to occur at various flood stages under present day development. A recurrence of the record February 1978 event would cause $5,014,000 in damage to 364 residences, $236,000 in damage to 5 commercial, industrial and public structures, and $70,000 in damage to roads, sidewalks and public utilities, for a total of $5,320,000 in damage.

The study area was divided into 4 damage zones, which are the same as the 4 hydrologic zones developed for this study. Recurring losses for structures in each zone are presented in Tables 1-4. Total recurring losses for structures are presented in Table 5. Recurring losses for roads, sidewalks and public utilities are presented in Table 6.

TABLE 1
RECURRING LOSSES TO STRUCTURES - ZONE 1

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Dollar Loss (Jan. 84 P.L.)
10.5	5	38	304,100
11.1	10	52	570,900
11.8	20	64	790,400
12.6	50	77	1,012,700
13.0	100	79	1,188,800
13.9	500	79	1,609,500
14.0	1000	79	1,665,500
14.4	10,000	79	1,907,200

TABLE 2
RECURRING LOSSES TO STRUCTURES - ZONE 2

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Dollar Loss (Jan. 84 P.L.)
9.7	5	88	583,800
10.2	10	104	961,400
10.9	20	112	1,325,200
11.8	50	113	1,708,700
12.0	100	113	1,793,000
12.8	500	113	2,216,300
13.0	1000	113	2,358,400
13.4	10,000	113	2,696,000

TABLE 3
RECURRING LOSSES TO STRUCTURES - ZONE 3

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Dollar Loss (Jan. 84 P.L.)
8.4	5	106	845,000
8.7	10	114	1,060,300
9.1	20	115	1,286,100
9.6	50	117	1,476,300
10.0	100	117	1,602,700
10.9	500	120	1,924,700
11.4	1000	123	2,169,700
13.0	10,000	123	3,510,400

TABLE 4
RECURRING LOSSES TO STRUCTURES - ZONE 4

Flood Elevation (NGVD)	Recurrence Interval (Years)	Structures Affected (Number)	Dollar Loss (Jan. 84 P.L.)
7.6	5	50	381,700
7.9	10	50	463,300
8.2	20	51	523,900
8.7	50	53	603,200
9.1	100	54	665,100
10.3	500	54	869,200
10.9	1000	54	1,004,300
13.0	10,000	54	1,916,200

TABLE 5
RECURRING LOSSES TO STRUCTURES - ALL ZONES

Recurrence Interval (Years)	Structures Affected (Number)	Dollar Loss (Jan. 84 P.L.)
5	282	2,114,600
10	320	3,055,900
20	342	3,925,600
50	360	4,800,900
100	363	5,249,600
500	366	6,619,700
1000	369	7,197,900
10,000	369	10,029,800

TABLE 6
RECURRING LOSSES TO ROADS, SIDEWALKS, PUBLIC UTILITIES

Recurrence Interval (Years)	Dollar Loss (Jan. 84 P.L.)
5	27,400
10	32,100
20	40,400
50	51,700
100	69,600
500	132,500
1000	177,500
10,000	319,000

ANNUAL FLOOD LOSSES

Expected annual flood losses were calculated using the "Interactive Non-structural Analysis" (INAP) computer model developed by the Hydrologic Engineering Center in Davis, California. The model computes expected annual damage on a structure by structure basis, thereby providing the flexibility to evaluate both structural and nonstructural flood control plans. Stage-damage information was input for each non residential structure. In the case of residences, stage-damage information for each of the 10 categories (Exhibit 1) was input. The elevation of the first floor and the elevation at which damage starts were also input for each structure. Stage-frequency data for the 4 hydrologic zones were then input. The computer model combined stage-frequency and stage-damage information to compute damage-frequency data and expected annual damages for each structure. Expected annual losses for the 4 damage zones are presented in Table 7. Expected annual losses for roads, sidewalks and public utilities are $22,000.

TABLE 7
ANNUAL LOSSES - STRUCTURES

Zone	Annual Dollar Loss (Jan. 84 P.L.)
1	$ 232,100
2	321,700
3	528,300
4	237,600
TOTAL	$1,319,700

BENEFIT ANALYSIS

A number of alternative structural plans have been investigated. All possible benefit categories were analyzed with regard to the study area and the alternative plans. Intensification benefits are not applicable to this study as the Point of Pines area is a residential community with no modification of existing use expected due to any plan of protection. Location benefits are also not applicable to this study as the area is already densely populated and fully utilized, so new activities would not move into the flood plain under any plan.

Inundation reduction benefits are applicable in the following categories.

1. Reduction of Existing Flood Damage
2. Reduction of Projected Flood Damage
3. Reduction of Emergency Costs
4. Reduction of Flood Insurance Overhead

1. <u>Reduction of Existing Flood Damage</u>

Three structural flood control alternatives were investigated, each providing a different level of protection. All three plans consist mainly of stone revetment improvements where floodwalls and revetments are now in place along the southern shore of Point of Pines. Natural sand dunes would be supplemented and renourished, with access points provided to be existing beach. On the north side of the point, along the Saugus River, new concrete floodwalls would be provided. The differences between the plans lie essentially in the height of the revetment sections, extending from Carey Circle to Alden Avenue. The maximum revetment height would be 18.3 feet NGVD for Alternative 1, 16.5 feet for NGVD Alternative 2, and 15.0 feet NGVD for Alternative 3. Stage-frequency curves, modified by each of the alternatives, were used to estimate annual losses for each of the four damage zones under the "with project" condition. The annual benefit was determined by subcontracting expected annual losses with the project from expected annual losses without the project.

Expected annual benefits and annual residual losses for each alternative are presented in Tables 8 through 10.

TABLE 8
REDUCTION OF FLOOD DAMAGE
18.3 Ft. Protection - Alternative 1

Zone	Expected Annual Damage Without Project (Jan 1984 PL)	Expected Annual Damage With Project (Jan 1984 PL)	Annual Benefit (Jan 1984 PL)
1	$232,100	$1,500	$230,600
2	321,700	1,700	320,000
3	550,300	4,300	546,000
4	237,600	1,700	235,900
Total	$1,341,700	$9,200	$1,332,500

TABLE 9
Reduction of Flood Damage
16.5 Ft. Protection - Alternative 2

Zone	Expected Annual Damage Without Project (Jan 1984 PL)	Expected Annual Damage With Project (Jan 1984 PL)	Annual Benefit (Jan 1984 PL)
1	$232,100	$6,800	$225,300
2	321,700	8,200	313,500
3	550,300	13,100	537,200
4	237,600	5,600	232,000
Total	$1,341,700	$33,700	$1,308,000

TABLE 10
Reduction of Flood Damage
15.0 Ft. Protection - Alternative 3

Zone	Expected Annual Damage Without Project (Jan 1984 PL)	Expected Annual Damage With Project (Jan 1984 PL)	Annual Benefit (Jan 1984 PL)
1	$232,100	$42,400	$189,700
2	321,700	46,000	275,700
3	550,300	65,500	484,800
4	237,600	26,600	211,000
Total	$1,341,700	$180,500	$1,161,200

2. Reduction of Projected Flood Damage

Under the without project condition, future flood damages are expected to increase. The additional damages can be due to further commercial or residential development of the floodplain and/or increases in the value of residential contents. As was noted above, significant increased development in the floodplain is assumed not to occur for the Point of Pines area. Therefore, projected flood damages can increase only due to the value of residential contents.

As real per capita income increases, the real value of residential contents will increase. As contents value grows, the potential dollar ammount of damage grows. The OBERS regional growth rate for per capita income is used as the basis for increasing the real value of residential contents in the future. OBERS information (1980) shows that per capita income in the Boston SMSA is expected to increase as shown in Table 11.

TABLE 11
PER CAPITA INCOME - BOSTON SMSA

Year	Per Capita Income	Annual Compound Growth Rate
1978	$5,557	1978-1985 - .030625
1985	$6,862	1985-1990 - .024375
1990	$7,737	1990-2000 - .019375
2000	$9,372	2000-2030 - .0190625
2030	$16,499	

Field visits to the study area indicated that the houses were in good condition. It was assumed that the neighborhoods would remain stable and that homeowners would increase the value of the contents in their homes. Review of residential damage survey information indicated that the existing value of residential contents was approximately 50% of the value of the structure. It is anticipated that the value of the contents will increase to 75% of the value of the structure. The 75% limit is based on the Principles and Guidelines. At the rates of growth shown in Table 11, it will take approximately 20 years to reach the 75% limit.

Flood damages under the without project condition are presented in Table 12. Damages with the alternative projects are shown in Table 13. Average annual benefits including projections of future flood damages are presented in Table 14.

TABLE 12
FLOOD DAMAGES WITHOUT PROJECT
Time Period

Property Type	(Existing) 1984	(P-1) 1985	(P∅) 1986	(P1∅) 1996	(P18) 2004	(P100) 2086	AAE[1]
Residential							
a. Contents	$435,400	448,700	459,700	567,900	661,300	661,300	572,200
b. Structure	721,600	721,600	721,600	721,600	721,600	721,600	721,600
c. Nonphysical	87,100	87,100	87,100	87,100	87,100	87,100	87,100
Commercial/ Industrial	75,600	75,600	75,600	75,600	75,600	75,600	75,600
Roads, Sidewalks, Public Utilities	22,000	22,000	22,000	22,000	22,000	22,000	22,000
Total	1,341,700	1,355,000	1,366,000	1,474,200	1,567,600	1,567,600	1,478,500

Footnote 1 : Average Annual Equivalent, 8 1/8%, 100-yr life.

TABLE 13
FLOOD DAMAGES WITH ALTERNATIVE PROJECTS

Alternative	(Existing) 1984	(P-1) 1985	(P∅) 1986	(P1∅) 1996	(P18) 2004	(P100) 2086	AAE[1]
1	1,341,700	1,355,000	9,400	10,200	10,800	10,800	10,200
2	1,341,700	1,355,000	34,300	37,000	39,300	39,300	37,100
3	1,341,700	1,355,000	183,200	197,700	210,200	210,200	198,300

TABLE 14

REDUCTION OF PROJECTED FLOOD DAMAGE[1]

Alternative	Expected Annual Damage Without Project (Jan 1984 PL)	Expected Annual Damage With Project (Jan 1984 PL)	Annual Benefit (Jan 1984 PL)
1	1,478,500	10,200	1,468,300
2	1,478,500	37,100	1,441,400
3	1,478,500	198,300	1,280,200

[1]Includes affluence benefits

3. Reduction of Emergency Costs

Emergency costs are defined as costs which result from emergency activities prior to, during, and after a flood. Emergency costs include expenses for flood emergency centers, communication facilities not otherwise needed, temporary evacuation assistance, flood fighting materials and personnel, additional police and fire protection, and public clean-up.

Available data on experienced emergency costs for Point of Pines consists primarily of information obtained after the February 1978 flood. During this storm a state of emergency was declared in Massachusetts and the President of the United States declared Massachusetts a "major disaster area". The Federal Disaster Assistance Administration (FDAA) opened a Disaster Assistance Center in Revere. Also, Follow-up Assistance on Service Teams (FASTS) were organized. "Project Concern" a six-month crisis counseling service was established by the Massachusetts Department of Mental Health. The American Red Cross, the Massachusetts National Guard and the regular U.S. Army also provided assistance. A list of agencies involved in emergency operations during the 1978 storm and the subsequent rehabilitation is provided in the main report as Table 6.

Activities associated with the 1978 flood are documented more fully in the February 1979 Corps report, "Blizzard of '78, Coastal Storm Damage Study". Although the aim of that study was to allocate flood costs and expenses to the community in which losses occurred, in many instances data would be summarized at the State or, in some cases, the city level. The summarized information shows that total public and private losses and expenses amounted to over $257,000,000 for the Commonwealth of Massachusetts. The comparable figure for the city of Revere is $16,140,000. Costs in Revere are, therefore, estimated to account for approximately 6% of all State flood costs.

The figures discussed thus far refer to all costs and losses, not just emergency costs. In many instances it is difficult to differentiate between emergency costs and funds derived from regular operating budgets. Investigation reveals that best estimate of true emergency costs is the list of funds made available from the President's Disaster Relief Fund. Monies made available to the Commonwealth of Massachusetts from this fund are as follows.

Temporary Housing	$12,500,000
Disaster Unemployment Assistance	$ 300,000
Individual and Family Grants	$ 4,000,000
Crisis Intervention	$ 461,526
FCO Mission Assignment	$ 50,000
Public Assistance	$20,691,695
TOTAL	$38,003,221

In order to estimate the portion of these emergency costs which were expended in the study area, several assumptions were required. Because NED damage surveys already include expenses for temporary housing this item was eliminated from the fund total, resulting in a new total of approximately $25,500,000. Next, because it has been determined that Revere accounted for 6% of total State flood costs, it was assumed that Revere accounted for 6% of State emergency costs. This resulted in an estimate of $1,500,000 in emergency costs for Revere during the 1978 flood.

Information from several damage surveys of Revere indicate that the study area generally suffers approximately 20% of all flood losses in the city. The $1,500,000 Revere total was, therefore, multiplied by 0.2 to obtain estimated emergency costs of $300,000 for the study area in 1978. Updated to January 1984, this cost is approximately $440,000. It should be noted that this figure may be somewhat conservative since no effort has been made to quantify the opportunity costs of the flood emergency (e.g., its value of time lost to individuals due to traffic diversion, time spent applying for disaster relief, loans, etc.)

Average annual emergency costs were computed by relating stage-emergency cost data to stage-frequency data using the 1978 flood as a base. Emergency costs for each of the 4 damage zones were based on 1978 recurring losses. The assumption that the relationship between emergency costs and recurring losses holds true for other flood events allowed the development of emergency cost-frequency data for each of the 4 damage zones. Expected annual emergency costs were computed using standard frequency integration techniques. Annual emergency costs were estimated to be $111,000.

Based on modified stage-frequency data, the structural flood protection would reduce a portion of the annual emergency costs. Annual benefits from reducing emergency costs for each of the alternative plans are presented in Table 15.

TABLE 15
REDUCTION OF EMERGENCY COSTS

Alternative	1	2	3
Emergency Cost Without Project	$111,000	$111,000	$111,000
Emergency Cost With Project	1,000	3,000	15,000
Annual Benefit	$110,000	$108,000	$96,000

4. Reduction of Flood Insurance Overhead

A national cost for the flood insurance program is its administrative costs. The cost of servicing flood insurance policies is determined based upon the average cost per policy, including agent commission, and the cost of servicing and adjusting claims. This benefit is considered for those structures which have obtained flood insurance. In Point of Pines, all 369 structures are affected by flooding, so it is assumed that 369 flood insurance policies can be written and in effect for the study area. The administrative overhead cost of $51 per policy, from the FY 1984 Reference Handbook to the Principles and Guidelines, is multiplied by the number of policies to determine the total annual cost for the study area. The average annual benefit for structural flood protection alternatives is equal to the annual cost of the administrative overhead, or approximately $19,000.

SENSITIVITY ANALYSIS

The computation of NED benefits necessarily involves assumptions about various components making up the benefits attirbutable to each alternative. Sensitivity analyses are conducted to present a range of benefit levels representing data and assumptions about which reasonable persons might differ. The assumptions examined here include risk and income projections.

Risk

In computing expected annual damage under existing conditions, it was noted that floodplain occupants are aware of the flood hazard and have either accepted the risk or taken steps to avert the risk. Many floodplain occupants accept the flood hazard in return for easy access to the city of Boston as well as the recreational opportunities available locally. Other floodplain occupants have taken measures to reduce the impacts of flooding, including floodproofing and the acquisition of flood insurance. Field damage surveys taken in the fall of 1980 form the basis for expected annual damages for the existing condition. Damage information was developed taking into account floodproofing measures and their effect on potential damages, and recognizing the widespread use of flood insurance in Revere. Data on flood damages is thus a reasonable representation of floodplain occupants' awareness and response to the risk of flooding.

The risk perceived by floodplain occupants can be altered by the implementation of flood protection plans. Perceived risk can be disproportional to the actual reduction in risk. However, for this study, residual losses with each level of protection were developed and therefore the risk has been quantified, allowing optimum plan development.

Projected Flood Losses - Income Growth

Growth in per capita income was based on 1980 OBERS projections. Affluence benefits attributable to this growth are presented in Table 16. A more conservative approach is to assume that per capita income will not increase, but will remain stable. Using this approach, the value of residential contents would not increase and affluence benefits would be zero.

TABLE 16

AFFLUENCE BENEFITS

Alternative	Annual Benefits (Jan. 1984P PL)
1	$135,800
2	133,400
3	119,000

ECONOMIC SUMMARY

Annual net benefits of the alternatives investigated are compared in Table 17 for the two potential scenarios discussed above under Sensitivity Analysis. The difference in benefit levels is due to the difference in assumptions regarding income growth and affluence benefits. The most likely scenario is that which includes income growth.

TABLE 17

COMPARISON OF POTENTIAL SCENARIOS

	Alt. 1	Alt. 2	Alt. 3
Conservative Scenario (No Affluence Benefits) Net Benefits	$1,025,500	$1,041,000	$ 892,200
Most Likely Scenario Net Benefits	$1,161,300	$1,174,400	$1,011,200

COMPARISON OF ALTERNATIVES

The three alternatives were compared to determine the NED plan, which maximizes net benefits. Table 18 shows annualized benefits, costs and benefit-cost ratios for the three alternative plans.

TABLE 18

SUMMARY OF ANNUALIZED NED BENEFITS AND COSTS
FOR ALTERNATIVE PROJECTS

Project Benefits and Costs	Alternatives 1 (18.3 ft)	2 (16.5 ft)	3 (15.0 ft)
Inundation Reduction Benefits:			
Existing	$1,332,500	$1,308,000	$1,161,200
Income (Projected)	135,800	133,400	119,000
Emergency	110,000	108,000	96,000
Flood Insurance	19,000	19,000	19,000
TOTAL BENEFITS	$1,597,300	$1,568,400	$1,395,200
ANNUAL COSTS	436,000	394,000	384,000
NET BENEFITS	1,161,300	1,174,400	1,011,200
BENEFIT/COST RATIO	3.7	4.0	3.6

As can be seen in Table 19, all three alternatives are economically justified. Alternative 2, which maximizes net benefits, is therefore the NED plan, and also the plan recommended for development.

APPENDIX G

NONSTRUCTURAL ANALYSIS

NONSTRUCTURAL MEASURES

In this section a discussion of the feasibility of nonstructural flood damage reduction measures in the Point of Pines area of Revere will be presented. Many of the nonstructural measures such as flood plain zoning, flood insurance, and flood forecast, warning and evacuation are implemented on a community wide basis. Therefore, analyses for some nonstructural measures in the following evaluation were completed for the Roughans Point area and, with minor modifications, are applicable for the Point of Pines area.

Small Walls and Levees

In analyzing this measure for the Point of Pines area, consideration was given to the topography, available space, compatibility with existing use, groundwater conditions, depth of flooding, and velocity of floodwaters. The flooding in this area has many unique characteristics. Much of the floodwaters enter at the southern extreme of the area where waves overtop the existing conditions. A sloping gradient causes the floodwaters to flow from south to north before ponding in an area of extremely low elevation near the Point of Pines Yacht Club, where water from the Saugus River causes flooding. Also, some breaching of sand dunes along Rice Avenue occurs.

The feasibility of using this measure to protect groups of structures was examined. Because of the heavy development in the study area and the depth of flooding, the use of small levees was considered physically infeasible. Small walls, however, were evaluated in a number of instances to reduce flood damage by offering 100-year or 500-year protection. The dynamic conditions of flooding posed a problem in determining design heights for ring walls being considered.

Design heights for ring walls have been developed from known high water marks which occurred during the flood of February 1978, a 100-year event in this area. The maximum high water marks in the area show depths of water at three to four feet for this event. Therefore, a wall height of six feet, allowing at least two feet of freeboard, was used as the 100-year wall height for that portion of the wall closest to the shoreline. The maximum high water marks along Lynn Way show depths of two feet, resulting in 100-year wall heights of four feet. All wall heights would be increased one foot for walls providing 500-year protection due to the one foot difference in stillwater tide elevation. This would result in wall heights of 5-7 feet, generally considered too high for ring walls around residential structures.

The costs for these walls were derived from generalized cost curves used in Stage 2 flood control studies and adjusted to be consistent with costs used for other New England Division projects. These costs include estimates for any necessary stop-log structures and pumping for interior drainage, while the cost associated with any valves needed to close existing sewer and storm drainage systems, which would allow water to get behind the walls, are not included. These costs would be developed in any subsequent studies for potentially feasible ring walls.

The ring wall layouts were primarily determined by using City of Revere tax assessment maps to locate property lines. Ring walls were evaluated for each street attempting to conform to existing property lines. Subsurface explorations to determine existing conditions have not been performed in the Point of Pines area, leaving unresolved questions regarding the need for lateral support. Therefore, the analysis of ring walls was completed for walls without bearing piles and walls with bearing piles spaced 10 feet on center. Any analysis for bearing piles spaced closer together would result in higher costs and a decrease in economic justification. Ring walls not economically justified with 10 foot spacing for bearing piles, will not be justified for walls with closer spacing.

The use of a wall protecting eight residences on Harrington Avenue was evaluated. The length of the wall would be 930 feet and, like all walls considered, has an average height of 5 feet. Also, two street openings would require closing when a flooding event was imminent. Unless otherwise stated, this holds true for the majority of ring walls evaluated. The benefit-cost ratios for this wall was 0.24 without bearing piles and 0.13 with bearing piles spaced 10 feet on center, not worthy of further consideration.

A wall, having a total length of 1,155 feet, was evaluated as a means to protect 13 structures on Goodwin Avenue. The benefit-cost ratios for this measure were 0.25 without bearing piles and 0.13 with bearing piles 10 feet on center, not economically justified. A total of 16 residential structures on Chamberlain Avenue could be offered 100-year protection by a wall with a length of 1,245 feet. The benefit-cost ratios without and with bearing piles were 0.18 and 0.10, respectively. Further consideration should not be given in either case.

An area of Delano Avenue comprised of 26 structures was examined as a potential candidate for a ring wall. This wall, having a total length of 1,575 feet, was found to have benefit-cost ratios of 0.31 without bearing piles and 0.17 with bearing piles, not economically justified. A large segment of Alden Avenue, totalling 27 residential structures, could be protected by a ring wall with a total length of 1665 feet An evaluation showed benefit-cost ratios with and without bearing piles of 0.82 and 0.42, respectively. If future subsurface exploration proves bearing piles for walls of this height are not needed, further consideration should be given to this measure.

Twenty six structures on Bickford Avenue appeared to be candidates for protection by a wall having a total length of 1,815 feet. An economic analysis showed this wall to be infeasible, having a benefit-cost ratio below 0.60 with and without bearing piles.

Two fairly large walls each protecting 31 structures, one on Lancaster Avenue and the other on Whitin Avenue, were evaluated. Each wall was found economically feasible if bearing piles are not needed. Lancaster Avenue can be protected by a 1,875 foot long wall having a benefit-cost ratio of 1.15, while the same wall with bearing piles shows a benefit-cost ratio of 0.59. The benefit-cost ratio for a 2,010 foot long wall with three stop log structures protecting Whitin Avenue is 1.12. Bearing piles spaced 10 feet on center reduces the benefit-cost ratio to 0.57. The feasibility of these walls will rely upon a determination of the need for bearing piles.

A wall to protect 20 structures on Fowler Avenue was found to be infeasible. This wall, 1,725 feet long, has benefit-cost ratios of 0.70 and 0.36 without and with bearing piles, not worthy of further consideration.

Walls to protect structures located on the three northernmost streets in the study area, Bateman Avenue, Witherbee Avenue, and Wadsworth Avenue, were evaluated. These walls ranged in length from 700 to 1,370 feet, all having, benefit-cost ratios greater than unity without the need for bearing piles. An evaluation with bearing piles spaced 10 feet on center reduced benefit-cost ratios below unity. Only the wall protecting Wadsworth Avenue, with a benefit-cost ratio of 0.79, showed any potential feasibility. A summary of walls, providing 100 year protection to individual streets, and without inclusion of bearing piles, is given in the following table:

TABLE I
Feasibility of Walls
Providing 100-Year Protection
(Without Bearing Piles)

Area Protected	No. of Structures	Length (Feet)	Height (Feet)	Annual Costs	Annual Benefits	BCR
Harrington	8	220	4	$47,707	$ 11,670	.24
		490	5			
		220	6			
Goodwin	13	220	4	56,963	13,990	.25
		715	5			
		220	6			
Chamberlain	16	200	4	60,661	10,970	.18
		825	5			
		220	6			

Delano	26	180	4	74,019	22,490	.30
		1220	5			
		175	6			
Alden	27	180	4	77,716	63,460	.82
		1305	5			
		180	6			
Bickford	26	180	4	83,865	45,290	.54
		1455	5			
		180	6			
Lancaster	31	175	4	86,328	99,400	1.15
		1520	5			
		180	6			
Whitin	31	230	4	91,908	102,740	1.12
		1605	5			
		175	6			
Fowler	20	120	4	80,191	56,360	.70
		1425	5			
		180	6			
Bateman	20	205	4	65,586	77,590	1.18
		985	5			
		180	6			
Witherbee	16	225	4	55,905	64,260	1.15
		735	5			
		175	6			
Wadsworth	8	140	4	38,312	54,550	1.42
		380	5			
		160	6			

A summary of the analysis for the same ring walls having bearing piles placed 10 feet on center is presented in the following table. The lengths and heights of the walls remain the same and have been left out of the table.

TABLE II
Feasibility of Walls
Providing 100-Year Protection
(Bearing Piles Spaced 10 Feet on Center

Area Protected	No. of Structures	Annual Costs	Annual Benefits	BCR
Harrington	8	$ 88,631	$ 11,670	.13
Goodwin	13	107,788	13,990	.13
Chamberlain	16	115,447	10,970	.10
Delano	26	143,326	22,490	.16
Alden	27	150,983	63,460	.42
Bickford	26	163,733	45,290	.27
Lancaster	31	168,836	99,400	.59
Whitin	31	180,537	102,740	.57
Fowler	20	156,098	56,360	.36
Bateman	20	125,872	77,590	.62
Witherbee	16	105,850	64,260	.61
Wadsworth	8	69,115	54,550	.79

The next step in the evaluation entailed a determination of whether an area covering more than one street could economically be protected by a ring wall. To eliminate wasted effort, the analysis concentrated on areas where walls were feasible or marginally feasible. The evaluation yielded two locations where fairly large walls protecting more than one street are economically feasible, both without bearing piles and with bearing piles spaced 10 feet on center. A wall with a length of 1,965 feet can economically provide 100-year protection to Bateman Avenue, Witherbee Avenue, and Wadsworth Avenue. A total of six stop log structures would require closing when a flooding event is imminent, a major weakness because the inability to close only one of these openings would render the wall useless. The benefit-cost ratios for this wall, without and with bearing piles, are 1.78 and 1.00, respectively. A second economically feasible ring wall can provide 100-year protection to homes on Fowler Avenue, Whitin Avenue, Lancaster Avenue, Bickford Avenue and Alden Avenue. This wall has a length of 3,410 feet and ten openings requiring closure during a flooding event. The benefit-cost ratios were determined to be 1.91 without bearing piles and 1.07 with bearing piles. In each case further consideration is warranted.

In an attempt to provide protection to as many properties as possible with ring walls, the previously mentioned wall protecting five streets was expanded to offer protection to seven streets with Delano Avenue and Chamberlain Avenue now included. The resultant benefit-cost ratios were 1.63 without bearing piles and 0.93 with bearing piles. Although this wall is economically feasible for further consideration, that additional portion offering protection to Delano Avenue and Chamberlain Avenue is not incrementally justified. The following table summarizes the analysis for walls protecting larger areas of more than one street.

TABLE III
Feasibility of Walls
Providing 100-Year Protection
(Without Bearing Piles)

Area Protected	No. of Structures	Length (Feet)	Height (Feet)	Annual Costs	Annual Benefits	BCR
Bateman	44	570	4	$110,088	$196,400	1.78
Witherbee		860	5			
Wadsworth		535	6			
Lancaster	135	885	4	192,280	367,250	1.91
Whitin		1630	5			
Fowler		895	6			
Bickford						
Alden						
Lancaster	177	1265	4	245,171	400,710	1.63
Whitin		1635	5			
Fowler		1290	6			
Bickford						
Alden						
Delano						
Chamberlain						

A summary of the analysis for the same ring walls with bearing piles placed 10 feet on center is given in the following table. The wall lengths and heights remain the same and have been omitted.

TABLE IV
Feasibility of Walls
Providing 100-Year Protection
(Bearing Piles Spaced 10 Feet on Center)

Area Protected	No. of Structures	Annual Costs	Annual Benefits	BCR
Bateman Witherbee Wadsworth	44	$196,557	$196,400	1.00
Lancaster Whitin Fowler Bickford Alden	135	342,335	367,250	1.07
Lancaster Whitin Fowler Bickford Alden Delano Chamberlain	177	429,550	400,710	0.93

Overall, the use of ring walls in the Point of Pines area may have fairly widespread applications based on economic criteria. However, issues remain concerning the ability of local authorities to close necessary stop log structures, social acceptability of such walls to local residents, and the need for bearing piles or some other means to provide lateral support in the wall designs. Any further investigation of these walls will most heavily rely upon input from affected local interests.

Flood Proofing Existing Structures

Flood proofing existing structures can be accomplished through a variety of means, most notably the use of shields to seal doors and windows, raising structures or protecting utilities. The feasibility of using any or all of these measures for structures in the Point of Pines area was evaluated.

Raising was determined to be potentially applicable to only 10 residences, single family or small two family homes having their first floors below the 100-year flood elevations. The small number of potential candidates for raising is due to the characteristics of flooding in the area with depths of 100-year flooding being approximately 2-3 feet. Also, a majority of the residential structures in Point of Pines have first floor elevations 4-6 feet above the ground resulting in primary living quarters usually being above any anticipated flooding at that location.

Generalized cost curves were utilized to determine the construction costs of raising each residential structure. These curves have been developed for various categories of residential homes, with type of foundation and number of stories being the primary criteria. The cost of raising these structures includes the relocation of mechanical and electrical equipment above any flood stages. Since the difference between the 100-year and 500-year flood elevations is only one foot and the added cost of raising the additional foot is not great, first floors of these homes would be elevated above the 500-year flood elevation.

Upon further investigation, the benefit-cost ratios for raising these residential structures ranged between 0.26 and 3.50. A total of 8 residential structures, located throughout the Point of Pines area, should be evaluated in more detail.

Flood proofing by keeping water outside the structure was evaluated for structures having concrete foundations. Many actions are required to flood proof a structure, including:

1. installation of temporary shields over openings.

2. application of a waterproof membrane to the foundation.

3. construction of a new waterproof cellar slab.

4. installation of sump pumps and check valves.

The majority of the structures in the Point of Pines area are one or two family residential structures, not potential candidates for the use of closures as a flood damage reduction measure. The foundations of these structures are not designed to withstand the hydrostatic forces which result when flood waters are prevented from entering the basement. The basement walls, unless specially constructed, can support these forces to a height approximately two feet above the basement floor. When the forces become greater, structural failure of the basement walls can occur causing much more damage than would have occurred by allowing water into the basement. This measure will not receive further consideration for residential structures.

The protection of household mechanical and electrical equipment can be accomplished in one of two ways, either by a watertight utility cell or by elevating the utilities in a room above the flood level. The feasibility of using a utility cell was evaluated for 9 residential structures, all having first floor elevations below the 100-year flood stage. Benefit-cost ratios ranged between .11 and 1.94, with 5 structures having benefit-cost ratios greater than 0.80. This measure should be given further consideration for these residential structures.

The elevation of mechanical and electrical equipment in a utility room was examined for 335 residences, all having first floor elevations above the 100-year flood stage. The benefit-cost ratios for this measure ranged between

0.01 and 6.17. A total of 153 residential structures having benefit-cost ratios greater than 0.80 appear to be potential candidates for implementation of this measure. Therefore, this measure should be considered further.

Flood proofing the few commercial, industrial, or public buildings in Point of Pines was also evaluated. The Roosevelt School located between Fowler Avenue and Whitin Avenue appears to be a candidate for flood proofing because of the relatively shallow depths of flooding, 2-3 feet during a 100-year event, and the type of construction. Another potential candidate is the fire station located on Lynn Way, which is flooded by less than a foot of water from a 100-year flooding event. Further analysis will be needed to determine the physical feasibility of flood proofing two churches in Point of Pines. In these instances, even if floodwaters could be sealed outside, the resulting hydrostatic forces acting on the foundation walls increases the likelihood of severe structural damage or even loss of life.

Relocation of Goods

Permanent or temporary protection of building contents in private homes and commercial/industrial establishments is largely the responsibility of the occupant. In Point of Pines, it is possible to move the vulnerable items to higher elevations or areas not inundated by floodwaters because all but a few residential structures have first floor elevations above any anticipated flooding. Property owners in this area could prevent a large portion of the flood damage by removing items from the basement to the first floor when a flood is imminent.

Relocation of goods is a measure which can not stand alone. It must be coordinated with a flood forecast, warning, and evacuation plan and a technical assistance program. A flood forecast, warning and evacuation plan must be developed to give property owners as much lead time as possible, while not forfeiting the reliability of any warnings given. The technical assistance program should be directed at informing residential or industrial occupants of the specific anticipated flood levels at their location and the options available to them.

Acquisition and/or Demolition

These two measures remove structures subject to extensive flood damages from the flood plain. In Point of Pines, they were considered potentially applicable to residences located throughout the flood plain.

Flood damages for Point of Pines are such that acquisition, demolition, and relocation is economically justified for a number of structures. The cost of relocating these structures was developed through a preliminary estimate of property values in Point of Pines. This value was then amortized to arrive at the average annual cost of removing that structure from the flood plain. It must be noted that the costs used in the analysis are preliminary, and will require refinement if relocation is considered a viable alternative to be carried into the next step in the planning process. Average annual benefits were derived using the methodology outlined in National Economic Development Benefits for Non-Structural Measures published by the Hydrological Engineering Center in October 1980. During this evaluation, location benefits such as increased market value of land or recreation benefits were not considered.

The evaluation showed that acquisition, demolition, and relocation were economically justified for 32 structures in the Point of Pines area which had benefit-cost ratios of 0.80 or greater. Many of these structures are located in the northern end of Point of Pines along Bateman Avenue, Witherbee Avenue and Wadsworth Avenue, with the remaining structures situated at various points throughout the study areas This measure should be evaluated in the next stage of the planning process.

Relocation of the existing structures was not evaluated in depth because no alternative sites are available in the immediate vicinity. Property outside the flood plain in this area is heavily developed, with no large open space areas suitable for a relocation of this type. Also, the traffic congestion in and around Point of Pines makes relocation of existing structures a very difficult proposition.

Flood Plain Zoning

The basic objective of flood plain zoning as a flood damage reduction measure is to minimize future flood damage by limiting the types of activity within the flood plain. The costs and benefits of effective land use control in the flood plain can be viewed in various ways. From a national perspective, benefits accrue because a reduction or elimination of flood damages to structures which are built out of the flood plain or built differently because of regulations. The expenses are the incremental costs of flood proofed construction on the flood plain or building at a site out of the flood plain.

At the present time, Revere does not have a flood plain zoning ordinance. This will change in late 1982 or early 1983 when Revere is scheduled to join the regular Phase of the National Flood Insurance Program, which requires land use restrictions in the flood plains of all participating communities. Basical these are:

1. New constrction of substantial improvements of residential structures within the area of special flood hazards are required to have the lowest floor (including basement) elevated at or above the 100-year food level.

2. New construction or substantial improvements of nonresidential structures within the area of special flood hazards are required to have the lowest floor (including basement) elevated at or above the 100-year flood level or, to be flood proofed up to the level of the 100-year flood.

3. New construction or substantial improvements of structures within coastal high hazard areas are required to be elevated on adequately anchored piles or columns to a lowest floor level at or above the 100-year flood level.

A key problem with these restrictions is they only consider regulating the potential for future flood damages up to the 100-year event. The 100-year elevation criteria of the National Flood Insurance Program was adopted by Congress as a minimum standard, but floods of greater magnitudes can occur. Consideration should be given to expanding the level of protection for the flood plain development regulations. The difference between the 100-year and 500-year flood elevations for most of Revere, especially those areas affected by direct or backwater tidal flooding, is approximately one foot. Given the small increase in cost for elevating or flood proofing new development the additional foot, it would be beneficial for Revere to implement more stringent regulations as a means to reduce future flood losses.

In Point of Pines, the principal development in flood-prone areas would be infilling, redevelopment or substantial improvements to existing structures. The majority of the study area is heavily developed with no large tracts of land suitable for potential future development. For this reason, flood plain zoning will have no significant effect in reducing flood damages in Point of Pines. However, a flood plain zoning ordinance should be enacted and enforced to reduce what limited potential for future flood damages exists. The City of Revere should give serious consideration to adopting regulations exceeding the minimum standards of the National Flood Insurance Program in order to insure that future development does not sustain significant flood damages.

Flood Insurance

The value of the National Flood Insurance Program as a flood damage reduction measure is twofold. First, the program provides a mechanism for individual property owners to recover their flood losses to a greater extent than available prior to the program. Although insurance does not cover all possible losses, it does cover damage to household contents and personal possessions to a much greater degree than disaster relief, thus reducing the financial impact on the victims of the flood. An attitude survey performed by the Corps of Engineers as part of the Roughan's Point study showed approximately 85% of the flood plain property owners had found flood insurance to be an attractive way to mitigate flood losses. It must be noted that a large number of these policies were taken out after the severe flood in February 1978, which caused substantial damage in Revere. The following table shows a breakdown of participation in the Program.

TABLE V
Participation in the National
Flood Insurance Program by Property
Owners in Revere
(Dec 31, 1981)

	Number of Policies	Amount of Coverage
Residential	1145	29,938,500
Non-Residential	118	5,009,600
	1263	34,948,100

Revere currently participates in the Emergency Phase of the National Flood Insurance Program, allowing property owners to pay subsidized premiums for insurance. These subsidized rates have recently been increased by the Federal Emergency Management Agency, administrator of the entire flood insurance program. With the increased rates it becomes more important that the right property owners obtain insurance. Those property owners in the severely flood-prone areas will still find flood insurance to be an attractive means to reduce the financial hardships caused by flooding, while flood insurance for property owners near the flood plain fringe may not be so attractive. A summary of the new flood insurance rates and maximum allowable coverage is given in Table VI.

TABLE VI

	Type of Insurance	Annual Premium Rate (per $100 coverage)	Maximum Allowable Coverage
Residential	Structure	$ .40	$ 35,000
	Contents	$ .50	$ 10,000
Non Residential	Structure	$ .50	$100,000
	Contents	$1.00	$100,000

Revere has suffered severe flooding in the winters of 1978 and 1979, resulting in reimbursement to a large number of Revere residents for flood damages sustained. A summary of insurance claims paid is given in the following table:

TABLE VII
National Flood Insurance Program
Paid Claims for Revere, Massachusetts
As of April 30, 1981

Year	Number	Amount
1974	54	$ 43,666
1975	1	478
1976	7	7,387
1977	18	30,280
1978	281	2,526,729
1979	451	1,315,614
1980	7	7,297
1981	6	3,062

The program's other value is its reduction of the potential for additional future losses. This is accomplished by requiring participating communities to establish land use controls on future development in areas vulnerable to the 100 year flood.

For Revere there is no purpose in conducting a feasibility analysis for the Flood Insurance Program; it will be implemented regardless of this study. However, there is a need to improve flood plain residents' understanding of the program so they will be fully aware of the program's advantages and better able to decide whether or not to purchase insurance.

Acquisition of Flood Plain Land

Acquisition of flood plain land is commonly of two types, (1) acquisition of full fee title, and (2) acquisition of land use easement. Acquisition in fee transfers ownership from the private to the public sector and thereby permits use for public purposes compatible with a flood hazard area. This measure is most appropriate for undeveloped land or land with few structures or other facilities. With an easement, the ownership, use, access and occupancy to the property may be retained by the owner, but certain uses incompatible with a flood hazard area are restricted.

Because the Point of Pines area is heavily developed, the purchase of flood-prone land either by title or easement was deemed ineffective and unnecessary. The limited potential for future flood damages in this area does not warrant implementation of this measure.

Tax Incentives

Tax incentives involve lower tax rates for flood plain property owners utilizing their land for agricultural, horticultural, or recreational purposes. As mentioned earlier, the Point of Pines area is heavily developed and implementation of tax incentives will not reduce flood damages. Also, most municipalities in the State of Massachusetts are suffering budgetary problems resulting from a recently enacted State law restricting local property taxes. Therefore, implementation of any form of tax incentives in Revere may be impractical.

Flood Forecast, Warning and Evacuation

The city of Revere, at the present time, does not have a structured flood warning and evacuation plan. The city does have an Emergency Operational Plan designed to provide general guidance for necessary actions during a disaster. However, the plan does not address specific actions to be taken during a flooding episode. Early recognition and warning of a potential flood episode can save lives and property if proper actions are taken.

A major shortcoming of the current Revere plan is the method of receiving forecasts of a potential flooding occurrence. The city does not have direct contact with the National Weather Service or any agencies to obtain forecasts of potential flooding events resulting in a short warning time for residents in flood-prone areas. At the current time the National Weather Service issues warnings when tides are expected to reach an established elevation, developed from delineation of historical flooding along the coast. However, this warning is not particular to any location and may not accurately forecast potential flooding in Revere. Steps should be taken to incorporate information given in the warning into a forecast concerning the location and severity of flooding about to occur in Revere.

The only method of getting the warning to flood plain residents is the Revere Audible Warning system, designed to warn of a possible military attack through a series of sirens or horns. This system does not alert the public concerning the type of emergency or provide the public any guidance and instruction for the particular emergency at hand. A provision should be added to allow for localized warning of residents in flood-prone areas either by house-to-house visits or police cars patrolling the area. To effectively accomplish this warning, city officials must be aware of those areas affected by flood episodes. These areas should include not only the areas that will be flooded but also areas that will lose evacuation routes, although they may not actually be flooded.

Once the flood warning has been disseminated, residents should be given specific information on:

a. the seriousness of the expected flooding and the locations that might be affected,

b. the actions the city is currently taking to reduce damages and the risk to life,

c. the actions that residents of affected area should take in order to reduce potential flood losses, and

d. what the process will be, should the evacuation of people become necessary.

Accomplishing the evacuation as smoothly as possible requires that specific evacuation routes be established and that such a list be distributed to those departments whose action will be required to accomplish the evacuation. Locations where flood evacuees will be temporarily housed should be determined. As an example, the Roosevelt School in Point of Pines may prove to be a fine shelter during some emergencies, but can not be utilized as a shelter during a flood episode. It is also necessary to insure that evacuees will be provided with adequate food and shelter during the emergency. The emergency shelters should have ample capacity for the expected number of evacuees, proximity to the area so they can be reached within the warning time, and accessibility along routes that are safe from flooding.

The existing plan addresses the need for the maintenance of vital services. However, it does not contain specific information with regard to the actual process of maintaining these services or the utilities. Also, the recovery process could be expanded to include actions required and the appropriate agency to perform these tasks.

In summary, Revere currently has a basic emergency operations plan, which can be expanded, with minimal effort, to include specifics regarding:

- Development of a structured flood warning system.
- Determination of areas that may require evacuation.
- Determination of safe evacuation routes.
- Provision of adequate emergency shelters.
- Location of areas where temporary flood proofing measures might be useful.
- Methods to provide vital services during an emergency.

The cost of implementing these procedures is relatively small, consisting primarily of administrative expenses and purchases of additional equipment such as pumps and sandbags. The benefits of including the above items in the existing emergency plans are:

- Reduction of potential social and economic losses.
- Reduction of potential losses to portable property.
- Early potential damage reduction, relative to other structural or nonstructural techniques.

In general, the use of flood forecasting, warning, and evacuation is a feasible way to reduce potential flood damages in the Point of Pines area of Revere. The costs of implementing this measure are small compared to the benefits derived from such a system.

Summary

Nonstructural flood damage reduction measures appear to be engineeringly feasible in a number of locations in the Point of Pines area. Measures such as small walls, closures, raising, utility cells, and utility rooms are economically and physically feasible for a number of structures. An issue which must be addressed is the social acceptability of these measures.

True protection for the Point of Pines area can only be provided by a comprehensive nonstructural plan. Because the acceptability of small walls remains an issue, two nonstructural plans have been evaluated. Plan N-A includes ring walls, while ring walls have been omitted from Plan N-B. A summary of the nonstructural plans is presented in the following table:

Table VIII
Feasible Nonstructural Plans
For Point of Pines

	PLAN N-A		PLAN N-B	
	Structures Protected	Cost	Structures Protected	Cost
Walls	221	$4,541,220*	---	---
Raising	0	0	8	$ 206,470
Utility Room	27	236,520	153	1,340,280
	248	$4,777,740	161	$1,546,750

* cost without bearing piles

A comparison between the two plans was made to determined the economic feasibility of each plan. Also, of prime importance is the amount of residual damage remaining after the plans are implemented. The following table presents those findings.

Table IX
Economic Feasibility of
Nonstructural Plans Considered

Plan	Annual Cost	Annual Benefit	BCR	Residual Damage	Damage Prevented
N-A	$373,760	$638,895	1.71	$190,665	0.77
N-B	121,000	240,283	1.99	589,277	0.29

Impacts

Although the Point of Pines area will continue to be inundated by flood waters, nonstructural measures can provide many structures 100-year flood protection. Protection of these properties will significantly reduce the social impacts of flooding. Residents must be evacuated when a flooding event is imminent and implementation of a more detailed flood warning and evacuation plan will lessen the health and safety risks facing residents. However, the time period of evacuation is reduced because damageable property will be protected. A negative social impact will temporarily exist during implementation of these measures, although this impact will dissipate as soon as the construction ceases.

The impacts associated with implementation of any small ring walls are twofold. The first impact, potentially worsening the flood stages, results from the walls changing the hydraulic characteristics of the area. The sloping gradient of the Point of Pines allows flood waters to flow in a south to north direction. Of course, any small walls constructed in a manner that restricts this flow could potentially increase flood depths outside the protected area. The result will be more severe damages to properties not protected and a negative benefit associated with the project. Secondly, the use of ring walls will have social impacts which may ultimately make implementation unacceptable. The aesthetic impacts of having walls in a neighborhood such as Point of Pines must be addressed.

Implementation of the nonstructural measures will have no major negative environmental impacts. No actions will be taken to alter the existing conditions along the shoreline, resulting in no adverse environmental impact.

Implementation

The nonstructural measures in Point of Pines would be implemented with Federal involvement, although local participation will be necessary. As a matter of policy, local interests must share a percentage of the first cost of implementing the nonstructural measures, with Federal interests contributing the remaining portion of project costs. As is the case with structural local protection projects, operation and maintenance responsibilities will be carried out by local interests.

The flood forecast, warning and evacuation plan would be implemented by the city during floods, although technical assistance from a number of sources would be available to Revere during the initial implementation. Revere and its residents should maintain familiarity with this program especially when there is a long interval between flooding episodes. When a flood occurs after a long period of flooding inactivity, severe damage results because people are unaware of the proper action to take.

Finally, Revere will join the Regular Phase of the National Flood Insurance Program in the near future, requiring the city to implement flood plain zoning. The city may want to enact zoning ordinances more restrictive than required by the NFIP, but these ordinances must be enforced if they are to effectively control development in the floodplain.

ACKNOWLEDGEMENTS

The New England Division (NED), U.S. Army Corps of Engineers prepared this report under the overall direction of Colonel Carl B. Sciple, Division Engineer and Joseph L. Ignazio, Chief of the Planning Division. The Plan Formulation Branch (PFB) of the Planning Division has overall responsibility for the study under the supervision of its Chief, F. William Swaine. Study management is provided by the Special Programs Section.

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This report was prepared for publication by NED's Word Processing Center under the supervision of Patricia A. Wysocki.

Thanks are extended to the city of Revere's Department of Planning and Community Development. Frank Stringi and Paul Rupp helped significantly with the study's public involvement program.

The Metropolitan District Commission (MDC), the Division of Waterways, the Office of Coastal Zone Management (CZM), and the Massachusetts Environmental Policy Unit (MEPA) of the Commonwealth of Massachusetts are acknowledged for their continuing cooperation in NED activities.